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From the Conference Chairs

This volume represents the proceedings of the first international conference on Communities and Technologies (C&T 2003). The C&T conferences are supposed to become a major international forum since the relationship between communities and technology is a topic of growing research interests. The nature of the field requires multidisciplinary research efforts involving researchers from different fields of applied computer science (Computer Supported Cooperative Work, Computer Supported Collaborative Learning, Artificial Intelligence, Information Retrieval, Human Computer Interaction, Information Systems) and social sciences (Cultural Anthropology, Communication Science, Economics, Management and Organization Science, Psychology, Political Science, Sociology).

Communities are social entities whose actors share common needs, interests, or practices: they constitute the basic units of social experience. For a number of reasons, researchers are increasingly interested in the topic of communities. First, within a global knowledge-based society, communities play a pivotal role. Problems such as new forms of political participation and civic engagement, the maintenance of cultural identities, or the integration of minorities need to be tackled on the community level. Second, communities also re-shape the processes of learning and sharing knowledge in and among organizations. While earlier approaches focused on storing and retrieving explicit knowledge represented in documents, communities are believed to be important structures to share implicit situated knowledge, as well. Given a new dimension by the use of electronic networks, inter-organizational cooperation is nowadays often discussed in terms of B2B-Marketplaces, Supply Chain Management, Virtual Organizations, or Strategic Alliances. Many failed attempts to implement these approaches can be attributed to inadequate attention to the issues of communities. Finally new types of communities, e.g. on-line communities, might change the relationships between producer and consumer. Information technologies may support or hinder these and other types of communities. So there are considerable research challenges ahead of us.

The C&T program of papers presented in this volume is the result of a very selective reviewing process. The conference received the unexpected high number of 120 submissions of full papers. After a thorough quality oriented reviewing process 24 papers were selected. Both the number of submissions and the quality and diversity of the program presented here are a testimony of the importance the C&T conference has already gained. We are sure that you will enjoy the papers in this volume.

The research papers in this volume are only one aspect of a diverse and dynamic event such as the C&T 2003 conference. Twelve very challenging workshops and an industrial consortium meeting are an other indication for the vivid research interest in this emerging field.

This conference could not have taken place without considerable enthusiasm, support and encouragement as well as sheer hard work. Many people have earned the thanks of those who attended and organized C&T 2003. In particular, we would like to gratefully thank:

- All those who submitted to the conference. The standard was very high and reflects well on the research work going on.
- All of those who contributed to the conference through workshops, and paper presentations. We are specially indebted to Larry Prusak for offering a very highly demanded tutorial.
- All of those who contributed to the organization of the conference. Setting up a major international conference is a complex endeavour and many people made significant

contributions to realizing a successful conference. A special thanks go to Tanja Antonijevic, Andrea Bernards, Marion Kielmann, Liesbeth Otten, Luzia Sassen, Arjen Schwarz and Monika Wagner. Daniel Breitscheidel spent lots of efforts maintaining the conference www-site. Thanks a lot for that!

- Those members of the Conference and Program Committees who gave so freely of their time and energy to ensure that the conference was both smoothly run and of high technical quality. The many individuals we owe our thanks to are listed elsewhere in this volume.
- F. Robbert van Berckelaer of Kluwer Academic Publishers who generously supported us in launching the conference and its proceedings.
- The many sponsors, supporters, and cooperating partners of C&T 2003 for their contributions to the conference.

These proceedings represent the starting point of an international discourse in the research field of communities and technologies. The future appears to hold considerable promise for us.

Marleen Huysman, Etienne Wenger and Volker Wulf

How Practice Matters: A Relational View of Knowledge Sharing

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Abstract. This paper addresses the issue of knowledge sharing practices in complex organizations. The authors propose that a refined understanding of the relational thinking underpinning practice theories is required if we want to further our comprehension of knowledge sharing and distinguish existing approaches. Knowledge sharing, we argue, is defined by the specific differences and dependencies in practices existing within or across communities. Changes in those differences and dependencies leads to the formation of new knowledge. Specifying the differences, dependencies and changes provides the first analytical step in understanding knowledge sharing as it takes shape in and across communities of practice. The authors apply this relational perspective to probe the discrepancies and complementarities among three seminal approaches to knowing within and across communities of practice.

Introduction

With the intensification of competition, the development of various forms of distributed and virtual modes of work, many scholars have turned their attention to knowledge sharing across groups and organizational boundaries. Extensive fieldwork on the socially situated nature of knowing has led to a broad recognition that knowledge sharing is a complex issue that goes beyond mere transfer of abstract bodies of knowledge (Suchman 1987, Lave 1988, Lave & Wenger 1991, Boland & Tenkasi 1995, Hutchins 1995, Engeström 1999). These

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scholars approach knowing as situated in communities of practice or activity systems. More recently, a number of these scholars have studied the problems associated with the sharing of knowing across communities of practice or activity systems (Orlikowski 2002, Carlile 2002). These include the use of boundary objects (Star 1989, Carlile 2002), boundary practices and processes (Wenger 1998, Carlile 2003), cross-communal forums (Boland & Tenkasi 1995), translators and knowledge brokers (Brown & Duguid 1998) or the engagement in knotworking (Engeström et al., in Preparation). The proliferation of concepts describing cross-communal boundaries leave more questions open than answered. For instance, it is not clear what distinguishes knowledge sharing across communities of practice from within a community of practice. More critically, does the practices that support knowledge sharing within a community also facilitates knowledge sharing across community boundaries?

In this paper, we wish to take a first step towards developing a framework that allows us to compare our understandings of knowledge sharing from within to across communities of practice. To accomplish this, we approach the common theoretical stand unifying these theories. We claim that a relational thinking lies at the heart of practice theory and ask what relation scholars highlight in their theories of knowledge sharing. To develop our framework we will apply a relational thinking to three seminal works that examine knowledge sharing from a communities of practice perspective (i.e., Lave and Wenger 1991,; Duguid and Brown 1991, Wenger 1998). To conduct this examination of knowledge sharing we focus on three relational properties. First, what are the differences embedded in the knowledge sharing relation? Second, what are the dependencies associated with the knowledge sharing relation? Third, when knowledge sharing takes place, what changes do we find in those differences and dependencies?

We start out by characterizing the particular relational thinking found in practice theories and, in particular, work on communities of practice. We draw attention to the critical factors that help us specify those relational dynamics. With these in hand we then approach the three seminal works on communities of practice by Lave & Wenger (1991), Wenger (1998), and Brown & Duguid (1991, 1998, 2001).

Relational Knowing in Practice

Relational thinking lies at the heart of practice theory and creates a particularly dynamic and open-ended approach with leeway for quite different formulations. Different scholars generally focus on different types of relations. Thus, a practice perspective does not necessarily translate into a unified analytical starting point. For example, a commitment to a practice theory does not mean a single theoretical position on the question of knowledge and knowledge sharing. In

order to compare different approaches to knowledge sharing and learning we need to specify the relational thinking that lies at the heart of practice theory.

In a relational thinking, subjects or social groups develop their properties only in relation to other subjects or social groups. Like points or lines in a geometric space social objects derive their significance from the relations that link them rather than from the intrinsic features of individual elements (Swartz 1997). Likewise, important features of a community of practice are not intrinsically features of that group, but rather those features obtain analytical significance only in relation to and by way of contrast to other communities of practice over time.

Relational thinking opposes itself to a "substantialist view" of social reality (Bourdieu 1984). A substantialist approach treats the properties attached to agents or social groups as forces independent of the relationships with which they act and exist. Such theories often tend to reify attributes of individuals or groups by detaching them from their social and historical contexts. This often takes place as substantive attributes are easier to identify or more convenient to count and so are assumed to be concrete or more "real" than relational attributes (Carlile et al. 2003).

Practice theory goes a step further than other theories focusing on interactions or relations. It looks not only at the recursive dynamics of a given relation but places everyday practice as the locus for the production and reproduction of relations. This produces a dynamic theory that proves helpful in breaking down problematic dichotomies imposed by non-relational theories. For example, the split between subjectivism versus objectivism (Bourdieu 1977, Giddens 1979), history versus unfolding interaction (Lave 1993), means and ends (Lave, 1988), agent and artifacts (Haraway 1991, Latour 1986) mental and manual labor (Barley 1986, Barley & Tolbert 1997, Brown & Duguid 2001).

The primary type of dichotomy opposed by practice theory involves the split between person and world, subjectivism and objectivism. This split has lead to two theoretical constituencies that rarely account for each other (Bradbury & Lichtenstein 2000). Those who focus on the individual, his or her knowledge actions, intentions, or goals leave the nature of the "world" or environment relatively unexplored. Others emphasize the world and its structures, while individuals and social structures are assumed to exist as uniform entities. Practice theory bridges the subjectivism-objectivism dichotomy because in practice the subject and the world combine and recursively interact (Giddens and Bourdieu). A focus on social practice emphasizes the relational interdependencies between subject and object, person and world. Lave & Wenger's (1991) theory of situated knowledge in communities of practice illustrates this relational approach well. Knowledge does not exist as well defined bodies in the form of rules or abstract models with intrinsic features. They argue that knowing and learning are relations among people engaged in an activity (Lave & Wenger 1991). Relational thinking

allows them to rethink action in such a way that structure and process, mental representation and skillful execution interpenetrate in everyday practices.

When considering the number of dichotomies that the various practice theories address, we begin to see the potential number of relations that could become important when studying knowledge sharing in complex organizations. In what follows, we highlight five factors helping us to clarify the relational dynamics of various practice theory approaches to knowledge sharing (see Table 1).

1	Bridging subjective knowing and objective structures	Where do scholars place themselves in the continuum between *historically* constituted relations and *emerging* relations?
2	Blurring category boundaries	What *concepts converge*?
3	Identifying the relational force(s)	Where does the author introduce the notion of *power*?
4	Characterizing the relations	What are the *differences*, *dependencies*, and potential *changes* associated with a relation?
5	Specifying the empirical practices	What actions are considered analytically central?

Table 1 – Five Analytic Factors in Specifying a Practice Based Approach to Knowledge Sharing

The Janus Head of Practice

The relational nature of practice theory is best expressed in its inherent duality: a focus on both structure and structuring. This Janus quality allows it to bridge the dichotomies between objective structure and subjective knowing. As noted by Brown & Duguid (2001), practice signifies both work itself and root tasks structured to help people learn to work. This does not leave us with an unproblematic and straightforward notion of practice theory. Different scholars generally place slightly different emphasis on the continuum between the two poles.

1. Bridging subjective knowing and objective structures

When building a framework for studying relations among communities of practice we need to be aware of how particular scholars place themselves on the continuum between primarily stressing 1) the historically constituted relations among participants and their unfolding practices or 2) the emergence of relations through ongoing interaction. At one end of the continuum we find theories that highlight the *historically* constituted *relations* between persons engaged in

socioculturally constructed practice and the context or community of practice. This perspective starts with the historically emergent contradictions that characterize the relations between subjects and the world. Artifacts, institutional arrangements, and long standing relations within or across communities of practice take center stage in an understanding of participants unfolding practices and thus, their production and reproduction of these larger structures. Different possibilities for actions, power, and interests are ubiquitous. Any particular practice is socially constituted and given meaning by its location in socially and historically generated systems of activity (Lave 1993). Consequently, social formations such as communities of practice must be defined largely through studies of how they reproduce and produce certain historically constituted relations. Marxist-inspired practice theories, such as Bourdieu, Engestrom, and, as we will see shortly, Lave, often take this as a point of departure.

At the other end of the continuum we find scholars giving prominence to productive rather than reproductive aspects of practice. Their focus lies on interpersonal relations among coparticipants in social interaction. Contexts or communities of practice are constructed as people organize themselves to attend to the ongoing challenges of social interaction. A context is not so much something into which someone is put, but an order of behavior of which one is a part. At this end of the continuum we find phenomenological writers such as McDermott (1993) and ethnomethologists (Suchman 1987, 1995). Lave (1993) summarizes these two perspectives on practice theory by pointing to how they answer the same questions but with different emphases on how relations are produced or reproduced in practice. One explores "how it is that people *live* in history; the other probes for how it is that people live in *history*" (ibid.: 21).

2. Blurring category boundaries

A consequence of the particular relational thinking promoted by a practice theory is that the boundaries among categories often blur. Some scholars celebrated this effect, and in other instances the blurring seems unintended. Lave (1993), for instance, notices that a theory of situated learning renders the distinction between "learning" and "change" meaningless. In Giddens' writings we observe that he provides nearly equivalent definitions of knowledge and power. He defines power as "can, is able to, or powers" (Giddens 1976) and knowledge or knowing as "inherent in the capability to 'go on' within the routines of social life" (Giddens 1984). Giddens does not seem to notice this or at least he does not celebrate the point as Foucault does with his notion of Power/Knowledge (Foucault 1980). Haraway (1991) and Latour (Latour & Woolgar 1986) explicitly use a practice theory to do away with the distinction between agents and artifacts.

Breaking down these dichotomies also means that social systems, such as communities of practice, are not divided into units like culture and organization,

but rather are depicted as a seamless whole (Ortner 1984), ecologies (Bowker & Star 1999, Brown & Duguid 1999, Brown & Duguid 2000), or communities of communities of practice (Brown & Duguid 2001). The analytical effort is not to explain one chunk of a system by referring to another chunk (e.g. how structure determines individual actions); rather the effort is to explain one system as an integral whole by referring to specific relations or asymmetries unfolding in practice. To put it differently, social groups in a relational practice theory are aggregates of common life chances, but not necessarily real social groups (Ortner 1984).

A community of practice is not defined in and of itself (or certain essential characteristics of its members), but through the relations shaped by its practices. Communities of practice are, thus, probabilistic constructs that should not necessarily be conflated with reality. This obviously makes it difficult to delineate a community of practice, a fact that we clearly see in the literature on the subject. Lave & Wenger, for instance, state that they leave the concept "largely as an intuitive notion...which requires a more rigorous treatment" (Lave & Wenger 1991: 42). The boundaries of the community are not given by the practice theory itself. As we have noticed a practice theory does not necessarily lead to a unified analytical stand. This, however, does not mean that all its parts have equal analytical significance. Different scholars will stress different factors. This leads to the last three factors introduced on Table 1.

3. Identifying the relational force(s)

Identifying the specific relation(s) highlighted by a given researcher constitutes the next step in defining and comparing practice theories. However, authors often do not state up front from what relations they build their particular practice theory, which makes identifying the connections across researchers difficult to make. Within sociology and anthropology, historically scholars have privileged the assumption that the most important forms of action or interaction for analytical purposes are those that take place in asymmetrical and unequal power relations. Why these types of relations are assumed to be central to any given system can probably be traced back to a Marxist influence from the seventies (Ortner 1984). Bourdieu's writings stand as a classic example of this as he analyzes cultural practices structured relationally around binary oppositions such as high/low, distinguished/vulgar, pure/impure, and aesthetic/useful (Swartz 1997). Yet, a practice theory does not necessarily lead to a left leaning theory as noted by Brown & Duguid (2001); other types of relations can equally well be placed under the analytical magnifying glass.

Given the long tradition of emphasizing asymmetrical relations we find that one often can pinpoint the particular relational thinking underlying a practice theory by how the author introduces the notion of power. Power, in a practice

theory, clearly highlights relational thinking. As we saw in Giddens' definition above, power is a relational force, not a possession; it does not explain anything in and of itself. Power can be affirmed only by being executed and is integral to action. In short, to ferret out the relations underlying particular practice theories one can often use discussions of power as a compass.[1]

4. Characterizing the relations

Spelling out the relational forces often reveals the contribution and limits of specific research approaches. Building on Carlile's (2002, 2003) relational approach to knowledge we characterize practice-based relations along three intersecting dimensions (differences, dependencies and change). A relational approach to knowledge and practice stresses the importance of understanding the *differences* among things and the consequences of these differences. For instance, knowledge developed within a community of practice can be seen as geared to make a particular effect or solve specific problems for its community members. These people are committed to and invested in their knowledge as hard-won outcomes. Equally important, knowledge developed by one community is not indifferent or inconsequential to members in another community. People's practices and their knowledge often exist in a *dependency* relationship to the practices and knowledge of other communities. In some cases these interdependent differences generate negative consequences that must be identified and resolved. A body of knowledge cannot be understood in isolation nor transferred from one social context to another without changes to its properties. It is defined by the social relations in which it exists and the differences and dependencies that characterize those relations. Equally important are *changes* among actors and their practices. The transformation of existing knowledge can only come about by changing the differences and dependencies in existing social relations.

5. Specifying the empirical practices

An analysis of the relational aspects is not complete without a closer look at the empirical practices emphasized by a practice theory. A practice can be anything people do. Consequently, a closer look at the empirical practices presented is often needed to understand the explanatory power of the framework. For instance, given the flexibility of a relational practice framework it is the empirical data that delineates a community of practice. First, what is taken to be the active unit? This can be historical individuals or social types or groups. As we will see shortly, the

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[1] It is interesting to notice that when practice theorists criticize each other they often claim that the counterpart does not look at power or does not develop the notion of power far enough. Such a critique can often be translated into a quest for highlighting other relational forces. In other words, the attacker wishes to give prevalence to one type of relations over another.

particular empirical practices in focus will specify the level of analysis pursued. Is it practices that highlight individual formations of identity (Wenger 1998), or communally distributed knowledge (Lave & Wenger 1991, Brown & Duguid 1991), or larger networks of practice stretching across communal and organizational boundaries (Brown & Duguid 2001)?

A second set of questions concerns the temporal organization of action. Bourdieu in his early work from Algeria, focuses on relatively short-term moves. Actor-network theories, in comparison, describe long-term practices involved in the enrollment and mobilization of actors around specific problems, goals and actions. Third, what *kinds of actions* are taken to be analytically central? Is it the mundane, routine activities of a tailor, or an involved and improvisational sharing of narratives and war-stories among technicians?

In summary, to develop a practice theory that describes how knowledge is shared across a broad set of circumstances one must specify the particular relations focused on and the actual empirical practices that help demarcate these relations. In what follows we will apply this analytic approach to a discussion of three seminal writings on communities of practice: Lave & Wenger (1991), Wenger (1998) and Brown & Duguid (1991, 2001).

Community-based approach to knowledge sharing

Lave & Wenger (1991) originally developed the notion of communities of practice out of an empirical interest in apprenticeship as an alternative to school based learning. They drew on five studies of apprenticeship in western and non-western societies: Vai and Golan Tailors in Liberia, Mayan Midwives in the Yucatan, US navy quartermasters, non-drinking alcoholics, and US supermarket meat cutters. These empirical choices shape to a large extend their further theorizing about knowledge and learning practice. All the settings characterized stand out as relatively small communities with a fairly low division of labor. One gets a sense of a 19th century organization of work with relatively tight groups with a relatively low dependency on other more specialized practices or groups.

The paramount relational force of the theory centers on the *differences* or tension between being an outsider or newcomer and being an insider to a set of practices. The authors focus on the process of becoming part of a shared practice. Apprentices embark on a trajectory towards gaining membership in a particular community. In this process they build *dependencies* between themselves and established members of the community by gradually becoming indispensable to the production and reproduction of the group. Apprentices are not mere observers; through their engagement in more and more activities they learn what constitutes the practices of the community. The differences and dependencies of this relationship also specify the direction of *change* as a community-based trajectory.

Lave & Wenger name this process "legitimate peripheral participation," essentially becoming an "insider." Newcomers start by participating in a practice, or set of practices, which makes them legitimate members of the community. As newcomers gradually master these peripheral practices their legitimacy increases within the community. They do not merely learn about practice, they become practitioners. Socially, newcomers move centripetally towards the center of the community (full membership) as they increasingly identify with the community's practices. They are on an inbound trajectory.

Lave & Wenger's use of the notion of power also points towards a focus on this inbound trajectory of change. Power relations are spelled out in terms of "access" and "transparency" of the activities, processes, and artifacts of the community allowed by old-timers in the community. The tension lies in the structuring of newcomers' access and the transparency they are granted.

Routine practices take up center stage in Lave and Wengers' analysis of apprenticeship. Given the dynamics of a practice perspective this does not refer to some preordained culture-sharing entity, but rather includes what other members do; what everyday life is like; how masters talk, walk, work; what other learners do and what they need to do to become full participants. The different apprenticeship studies referred to by Lave & Wenger describe slightly different temporal organization of practice. Hutchins' (1991) research, for instance, analyzes the minute unfolding of practices by quartermasters on a naval ship, whereas Jordan (1989) describes practices as they unfold over longer stretches of time among midwives. In general through, Lave & Wenger (1991) focus on practices as they evolve in the newcomers community-centered trajectory of change.

In emphasizing the newcomers' inbound trajectories in communities of practice Lave & Wenger (1991) stress the reproductive and historical dimension of practice and thus leave the improvisational and unfolding and productive aspects of practice largely un-illustrated in their empirical analysis. In fact, Lave & Wenger suggest that we delineate communities of practice in historical terms, based on their reproductive circles (1991: 100). They argue that if the place of knowledge is within communities of practice, the question of learning must be addressed within the developmental cycles of that community. This reproductive cycle (i.e. legitimate peripheral participation) becomes a diagnostic tool to distinguish among communities of practice.

Independent and Unconnected

The prominence of a practice's reproductive aspects has several consequences for how we use the notion of communities of practice because it emphasizes community-based trajectories of change. Newcomers' inbound trajectories towards full participation in the community take precedence over other forms of

trajectories that may involve many communities. The danger, thus, in this particular framework developed by Lave & Wenger (1991) is that it depicts communities of practice as largely independent and unconnected. The 19^{th} century sense of work given by the empirical examples of apprenticeship does not force the two authors to include more than one community of practice in their analysis. The relatively small communities of craftsmen and manual workers do not demand a multi-communal perspective, as do modern organizations linked up to the rest of the world through various forms of information technology. A new focus on relational forces and practices as they unfold within the boundaries of a community of practice has largely been translated to the broader use of the term. When studies look at more than one community they often analyze these one at a time, emphasizing their profound differences in modes of communication and ways of organizing participation and knowledge. See, for instance, McDermott's study of children's learning disabilities (1993) or Thoresen (1995) Naslund's (1995) studies of learning and use of information technology within multiple communities of practice. To do Lave and Wenger justice we need to mention that in more recent publications they both expand their focus to participants' trajectories in and across multiple communities of practice. Let us now turn to Wenger's (1998) perspective on communities of practice.

Identity

Identity often plays a key role in socio-cultural theories on learning. A theory of situated learning is no different because learning and knowing involve the whole person (Lave & Wenger 1991: 53). We do not solely learn facts about the world; we develop an ability to act in the world in socially recognizable ways. This turns knowing into complex social processes that involve the acquisition of identities and reflect both how a person sees the world, as well as how the world sees the subject. In everyday life it is, thus, difficult and often unnecessary to determine exactly where the sphere of the individual ends and where the sphere of the collective begins. Knowing and learning mirror the social contexts in which the whole person learns and puts their knowledge into use. Activities, tasks, functions, and understandings are part of a broader system of relations where a person becomes a member of a group with interdependent participants.

The broader organizational literature on communities of practice has, to some degree, picked up on the notion of identity. These writings generally start with the premise that when people work together, they inevitably form small informal networks of relationships. These go beyond formal organizational patterns and build instead on proximity, personal attraction, and common background among the members. An emphasis on identity, however, poses two potential problems. First, the notion of identity easily loses its position in a relational framework and solely defines the similarities among individuals (i.e. the set of characteristics by

which people are recognized). Galagan (1993) and Stewart (1996), for instance, argue that people do not just work together in communities; they often socialize together and in many cases start to look and talk like each other.

Secondly, theories on identity often lose sight of the spatial dimension of a person's social being. By focusing on the person's self-biographical work one easily ends up considering identities as merely stretching over the temporal dimension of an individual's past-present-future path (i.e. their trajectory). In particular, theories emphasizing the narrative structure of identity (Giddens 1991) and the person's negotiation of its complexity easily neglect spatial dimension of social practices, i.e. its cross-communal infrastructure. One imposes a beginning, middle, and end to disjointed events in the plotting of a story and the construction of identity in time (Dreier 1999). Eventually, the invested nature of knowledge and contested nature of practice among multiple participants easily falls out of our analytical apparatus when we turn our attention to people's tinkering with their self-narratives. It is too easy to focus on the self and a person's search for a seamless story in an otherwise heterogeneous life.

Wenger (1998) places a particularly strong emphasis on the concept of identity. He dedicates half his book to the notion of how people negotiate ways of being a person in a context. According to Wenger, practice inevitably deals with the profound issue of how to be a human being in relation to other people. The formation of communities of practice in fact, "*is* the negotiation of identities" (Wenger, 1998: 150). Nevertheless, he escapes the danger of losing the spatial dimension of learning and knowing by turning identity into a *relational* term playing much the same role as practice.

In the end, Wenger seems, if not to fuse identity and practice, then to shift focus from practice to identity as the fundamental building block in a social theory of learning and knowing (Wenger 1998: 156). He argues that by using the notion of identity we avoid the simplistic subject/world dichotomy without doing away with the distinction. We notice that "practice" plays the very same defining role in a practice theory.[2] As a core relational term "identity" should specify the differences, dependencies and change between the subject and the world. Not surprisingly, Wenger (1998: 20) discusses the notion of power only in chapters on identity. It is also here that he specifies the differences, dependencies and changes that define a person's practices/identity. Let us briefly summarize his comprehensive discussion of the topic.

The core *differences* constituting our identity fall along the two abstract dimensions of time and space. The person must incorporate not only a past and a future in the present process of learning particular practices; they also need to negotiate a nexus of multi-membership across several communities. People's

[2] At times Wenger also talks about identity of practice/participation. In these situations the notion of identity seems to mirror not so much practice but communities of practice, the difference being that the focus is shifted from the collective to the person (Wenger, 1998: 219).

engagement across communities requires them to negotiate the differences in knowledge coming from differently situated perspectives which get expressed and worked out in people's identities. In Wenger's words:

> *We all belong to many communities of practice, to some in the past, to some currently; to some as full members, to some in more peripheral ways. Some may be central to our identities; some incidental. Whatever their nature, these various forms of participation all contribute in some ways to the production of our identities. (Wenger 1998: 165).*

Wenger introduces the core *dependencies* of his relational theory of identity as a "social ecology of identity," which involves three dimensions: participation/ non-participation, modes of belonging, and identification in communities versus ownership of meaning. At its root this broad framework greatly elaborates the ideas underlying Lave & Wenger's (1991) notion of "legitimate peripheral participation," in so far as it draws attention to a person's relative position in regard to communities of practice. Power is no longer just expressed along the relation between newcomers and old-timers, but also in the tension between people's identification with a community versus their ability to control what communities they belong to and define the knowledge and meanings ascribed to the activities and objects of the community.

Change falls along the dimensions laid out by the core dependencies. The potential for change and, thus, new knowledge, is given by a person's various peripheral or marginal positions in regard to several communities; learners combine different modes of belonging through their engagement and alignment with practices in multiple communities. This makes learning and changes in knowledge a process of social reconfiguration through which people alter their identification to a nexus of communities in which they hold more or less ownership in the knowledge and meanings used.

Wenger clearly introduces a multi-communal perspective. He distinguishes between a perspective of practice, which highlights communities, and a perspective of identity that highlights the person's negotiation of a nexus of multi-membership. Wenger does not elaborate on these communities' differences, interdependencies, nor on the changes dependencies may generate. When picturing the relations among communities Wenger uses Venn diagrams that posit the relative overlap of two communities as a way to represent their degree of difference (Wenger 1998).

The dynamic relations among multiple communities of practice emerge only with the introduction of identity in Wenger's framework. It is here that we see the dependencies expressed as power relations played out in a person's configuration of their identity of participation. However, these discussions of multi-membership remain abstract. Wenger presents only general examples and draws little from his ethnographic work among insurance claim processors. One reason for this may be that the study focused its attention on one community and not the movements or interactions among two or more settings. The result is that we do not get a good

sense of the types of tensions and dependencies in cross-communal relations and the changes they generate. Tensions lay with the individual and his or her struggle with the negotiation of an identity, not primarily with the community of practice. Wenger assures us several times that communities can be the breeding ground for social venom, yet, we get little sense of this tension in his examples of claim processors' shared practices, mutual help, and general reflection on their work life in relation to other aspects of their being.

In brief, Wenger's profound theory of learning turns the differences, dependencies, and changes fueling the production and reproduction of knowledge into a personal matter, not an issue laying at the core of a community of practice or a communities of communities of practice (i.e. the organization). Wenger has good reasons for this focus. With a social theory of learning that emphasizes the person's trajectories of change, it makes sense to choose a level of analysis that calls attention to the person. Furthermore, identity as discussed here stresses a person's agency, a dimension easily overlooked when focusing on cross-community relations.

For our purposes, i.e. investigating knowledge practices in a nexus of communities of practice, identity can become a liability if it moves to the center stage as it diverts our attention from the negotiation and improvisation that produces and reproduces cross communal relations embedded in objects, ends, divisions of labor, and institutional forms of participation. Organizational members' investment in their identities clearly plays a central role in complex cross-communal relations, but an over-emphasis on this process could blind us to the ongoing power relations in communities of practice and the invested nature of knowing and learning as it unfolds among a group of participants across contexts. Wenger's work contains many insights pointing to a social theory of knowledge in regard to cross-communal relations; we just have to dig them out from a narrative built around the notion of identity.

Sharing Practices Within Shared Practices

By far the most widely adopted approach to situated knowledge and communities of practice within the organizational literature stems from Orr (1996) and Brown & Duguid's (1991, 2000 a, b) adaptation of Lave & Wenger's work. The overall practice theoretical perspective remains the same, but new empirical data shifts our attention to other relational forces. Apprentices' everyday routine practices are replaced with Orr's ethnographic study of Xerox service technicians' engagement in knowledge sharing practices (Orr 1996). Specifically, Brown & Duguid (1991, 2001) emphasize how Orr's technicians create and share narratives over and about troublesome copy machines. Facing novel problems the technicians join forces in diagnosing problems through narration; the integration of various facts of the situation is accomplished through a conversation. In their

search for inspiration, they tell stories. These stories generate a sufficient interplay among memories, tests, the machine's responses, and the technicians ensuing insights that lead to diagnosis and repair. Stories also act as repositories of accumulated wisdom among the technicians. The knowledge produced, thus, emerges out of collective effort around a shared practice. This form of social construction is highly situated and highly improvised (Brown & Duguid 1991: 47). It is through their collaborative and continual development of these practices that shared meaning for interpretation of complex activities gets formed, transformed, and transmitted.

In Brown & Duguid's approach we see a shift in not only the types of practices the analysis highlights, but also a shift in emphasis from reproductive practices (i.e. becoming part of a community and its practice) towards productive practice (i.e. improvising new solutions to novel problems). In short, we move along the relational dimension between history and lived interaction. The former demarcates a community of practice primarily by its reproductive cycles; the latter defines a community of practice around its improvised extension of activities within and beyond existing practices. It is the value of continuously-evolving, socially-distributed knowledge that seems to tie community members together in Brown & Duguid's analysis. We find a comparable emphasis on the productive aspects of practice in workplace studies building on Giddens' (1984) structuration theory (Barley & Tolbert 1997, Orlikowski 1992). It is in the everyday unfolding of practice that new structures continuously emerge, such as socially distributed repositories of knowledge embedded in technicians' war-stories. We should notice that this does not mark a rejection of reproductive forces, history or structure. The technicians' sharing of narratives not only produces new knowledge, but also maintains and reproduces existing distributed knowledge, providing highly effective loops for insights into the continuous process of problem identification, learning, and knowledge production.

The question remains: around which relations do the technicians' shared practices build? It is not the issue of access and transparency among newcomers and old-timers. Rather Brown & Duguid point to two other types of tensions feeding the production of new knowledge within a shared practice. First, Brown & Duguid (1991) describe the subtle differences, dependencies and changes occurring within a shared practice. People engaged in a shared practice draw on separate experiences and do not form an entirely homogeneous group given their various backgrounds and experiences. These differences allow community members to engage in a task by complementing each other's activities in an unfolding improvisation. Dependencies develop as participants provide for one another social "affordances" that scaffold knowledge creation in practice (Cook & Brown 1999). The telos of change, then, centers around the expansion of the distributed knowledge base, the production of novel activities, and the continuous

molding of a shared perspective, which reflects the local condition of their shared practice.

Recently, Brown & Duguid (2001) extend this idea by introducing the notion of networks of practice. Brown & Duguid raise the level of analysis from the closely shared practices of community members to broader and more loosely shared practices of professions, occupational networks, or epistemic cultures (Knorr Cetina 1999). Within these networks too, we find a fine differentiation of practices creating complex "ecologies" of knowledge (Brown & Duguid 2000).

Losing a Relational Perspective

The idea of sharing practices within communities of practice has proven immensely popular within both the academic and practitioner-focused organizational literature in comparison with the notions of legitimate peripheral participation and identity. The literature celebrates the direct and extensive sharing among community members collaborating directly, using each other as sounding boards, and learning from each other in lunch room conversations, across cubical walls, or other informal occasions (Galagan 1993, Marshall et al 1995, Smith 1997, Stewart 1996). These exchanges range from the mundane information needed by someone on the fly or small behavioral instructions during a particular activity, to more elaborate and ongoing sharing of narratives. Some authors emphasize the use of information technology as an integral part of the sharing (Erickson 1997, Gardner 1998, Manville & Foote 1996, Marshall et al 1995, Smith 1997, Stewart 1996).

Brown and Duguid's (2001) notion of "networks of practice" tends to fit these descriptions of virtual and computer mediated sharing practices better than the more narrow terms of "communities of practice." An overarching focus on sharing practices in the broader literature, however, often loses sight of the thorny relational thinking forming the foundation of a practice theory. In these cases the notion of a "shared practice" shifts from being a relational term to becoming a self-contained category, a container for particular self-explanatory characteristics of a community. In doing so, they end up reproducing a notion of community developed in the English language depicting a coherent group of people organized around a set of shared characteristics and opposed to larger social formations. In Williams' words:

> *Community can be the warmly persuasive word to describe an existing set of relationships, or the warmly persuasive word to describe an alternative set of relationships. What is most important, perhaps, is that unlike all other terms of social organization (state, nation, society etc.) it seems never to be used unfavorably, and never to be given any positive opposing or distinguishing term (Williams 1983).*

The neglect of a relational thinking often translates into an overly romantic interpretation of communities of practice, as illustrated by Stewart:

> *Perhaps most intriguing, communities of practice are responsible only to themselves. No one owns them. There's no boss. They are like professional societies. People join and stay because they have something to learn and to contribute. The work they do is the joint and several property of the group-cosa nostra, 'our thing.' (Stewart 1996).*

We lose slight of any contested practices and are left with a picture of what must be close to a managerial utopia where employees do not need supervision nor surveillance, but generate their own motivation, build group responsibility, and set goals in a desire to work more effectively, learn, and improve their work performances (Hamel & Prahalad 1996, Handy 1996, Stewart 1996).

Cross-Communal Relations: Canonical vs. Non-Canonical Practices

Brown & Duguid (1991, 2001) themselves escape the pitfall of losing practice by bringing forth a second relational force, which lies between communities or networks that do not share a practice. In their more recent publications (2001) this relation is cast as the difference between "sticky" versus "leaky" knowledge. Following the concept of situated knowledge Brown & Duguid (2001) describe how knowledge rides along the rails laid out by shared practices. Where practices are not shared we find different assumptions, outlooks and interpretations of the world, and different ways of making sense of our encounters. Knowledge sticks to communities (or networks) sharing practices and leak beyond community boundaries only when the practices underlying it become common in other places. Most strongly, we see these differences within organizational boundaries where a division of labor, hence of practices, and knowledge balkanize the different communities of practice.

From this perspective, we find that organizations embrace communities with fundamentally different practices, each presiding over local knowledge. However, we are left with the question of how these communal practices differ empirically, apart from being merely different in terms of their practices (Brown & Duguid, 2001). In their early work on communities of practice Brown & Duguid (1991: 41) hint at some possible differences among an organization's community of communities. The authors' narrow in on the relation between *canonical* and *non-canonical* practices. This translates into the difference between an espoused practice of an organization and the actual practices of its different communities. On the one hand, we find the opus operatum, the canonical view, which tends to see actions in terms of the task alone and does not include the process of doing the task. The modus operandi, on the other hand, involves the way the task looks to someone who works on it over time and space. This highlights the constantly changing conditions of work that forces community members to improvise practices which rarely map onto the canonical practices. The tension between canonical and non-canonical practices largely translate into the difference between managerial practices and perspectives versus non-

managerial community practice that are subject to the espoused perspectives and abstract accounts of their leaders. Often resulting in a tension between the knowledge and practices of a community of managerial practitioners who develop an outlook that does not comprehend the daily work conditions of their subjects. Other communities find that their daily work inevitably involves tricky interpolations between abstract accounts and situated demands. We notice that by drawing attention to asymmetrical relations among different groups Brown & Duguid also raise issues of power as a relational force central to many theories of practice.

Innovation, and thus change, largely springs from this tension between canonical and non-canonical practices according to Brown & Duguid (1991: 50). Community members pioneer new practices as they continue to develop a rich, fluid, non-canonical worldview in order to bridge the gap between their organization's official view and the challenges of their daily work conditions. By ignoring preset rules and traditions, the social construction of a community of practitioners can produce new ways to solve problems. In their more recent work Brown & Duguid (1998, 2001) further develop this perspective to encompass the relationship between multiple communities within an organization. Organizations, in contrast to networks, deliberately embrace communities with fundamentally different practices, presiding over a particular division of labor, and hence of practice and knowledge. Communities with different practices have "different assumptions, different outlooks, different interpretations of the world around them, and different ways of making sense of their encounters" (Brown & Duguid 1998).

Management faces the challenge of facilitating the relationship between their own canonical views of the organization with the innovative work, changing practices, and emerging new knowledge of one specific community. Organizations' competitive edge and hence management's success, depends on their ability to coordinate the different practices and knowledge across these many communal divisions. To make and market inventions involves coherent systems of complementary knowledge presiding in different communities of practice. Managements, then, find themselves in the precarious position where they have to make trade-offs between coordinating differences among communities and letting each community explore, specialize and develop new innovative processes based on their unfolding non-canonical practices. Management must weigh the effects of their synchronizing canonical systems versus letting each community further develop separately.

Seen from a relational perspective, we notice that Brown & Duguid most clearly articulate differences, dependencies and change among communities from a management perspective. Organizations embrace a number of different "epistemic cultures" (Knorr Cetina 1999) developed within the shared practices of particular communities and networks. The *dependencies* are seen from a

managerial perspective as choices between letting individual communities specialize and innovate versus coordinating and refining the relations among existing knowledge in the organization. The *change* process in focus, then, involves the ways organizations manage to coordinate knowledge across these divisions better than both their competitors and the marketplace.

What Brown & Duguid's work does not cover are the differences, dependencies, and changes among communities in the organization that do not necessarily fall along the canonical/non-canonical divide. We are left with little sense of the differences, dependencies, and changes as they develop between communities within an organization, nor what they look like from the perspective of communal members. From Brown & Duguid's analysis we get the sense that organizational members, apart from management, predominantly concern themselves with developing and refining their communal knowledge and epistemic cultures with little concern for the practices of other communities, apart from management's colonizing perspectives. Brown & Duguid (1998, 2001) hint at the positive effects of "translators, boundary brokers, and boundary objects in negotiating the epistemic differences among communities that do not share practices. These are introduced as essential tools in the coordination among epistemic cultures within an organization's division of practice and knowledge. Yet, we do not get a sense of the concrete dependencies that drive these negotiations and the stakes that organizational members bring forth when engaging in such boundary practices. In short, our analyses calls for a further exploration of the *dependencies* and *changes* characterizing the relations across shared practices.

Conclusion: Knowing the relations in practice

We have attempted to find a perspective that allows us to describes knowledge sharing practices across a broad set of circumstances in a complex organization, claiming that approaching theories on communities of practice as relational theories offers a first important step in this direction. This relational thinking goes to the core of practice theories and helps us understand the specific relations around which knowledge sharing takes form. Analysing three seminal works on communities of practice we show that early formulations emphasized intra-communal knowledge sharing relations, whereas more recent work include cross-communal perspectives, though in a somewhat elusive form. Equally important, our analysis points out that the relational core of a knowledge sharing theory easily falters. When that happens, we lose our ability to understand cross-communal dynamics whether these are embedded in virtual organizations, supply chain management, or B2B relationships. We end up instead with a perspective that focuses on the storage and retrieval of explicit knowledge represented in information systems. Knowledge becomes an object shared within and across

community boundaries without consequence for the community in which it originated. A relational approach, in contrast, stresses that knowledge matters for all the involved parties. Technologies facilitating such sharing cannot be seen as mere vessels transporting bodies of knowledge across community boundaries. They become important grounds on which communal relations get defined and changed.

What *differences* characterize knowledge-sharing relations in communities of practice?
What *dependencies* characterize these differences in communal practices?
What *changes* do we find in the differences and dependencies within or across communities?

Table 2 – Examining the relational nature of knowledge sharing

We have suggested three central questions when laying open the knowledge sharing relations (see Table 2). One starts out probing for the differences in knowledable practices, allowing for the description of the dependencies among specific constituencies that motivates the knowledge sharing. The dependencies help one understand why community members often associate their hard-won knowledge with certain stakes. Knowledge sharing, or the implementation of new information systems, is not just a matter of communication within or across communities. Shareing knowledge requires community members to resolve the dependencies that exist between them. Each party may have to alter his or her own knowledge in order to allow for the sharing. In other words, sharing often leads to changes in the differences and dependencies among communities. Obviously, calling attention to the differences, dependencies and changes taking place in communal relations constitutes only a first small step towards a comprehensive framework on knowledge sharing. Yet, it offers a good staging ground to develop empirical analyses of knowledge sharing that untangle the entwined nature of knowledge, communities, and technology.

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Structural Analysis of Communities of Practice: An Investigation of Job title, Location, and Management Intention

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Abstract. The community of practice phenomenon has been extensively studied in qualitative terms, but there has been relatively little research using quantitative techniques. This study uses the common social network measures of connectedness, density, graph theoretic distance, and core / periphery fit to examine how groups defined by different characteristics align with community of practice theory. Specifically, it investigates the roles of job title, location, and management intention relative to the structural characteristics of communities of practice. Workers were assigned to groups based upon their job title, job group, division, location, and emergent behavior (results of hierarchical clustering). Initial results suggest that grouping employees by their emergent behavior yields network measures that are most closely related to community of practice theory.

Introduction

Communities of Practice have received considerable attention from practitioners and researchers in the last ten years. From a strategic viewpoint, communities of practice are important to the firm because they are thought to be repositories for knowledge, its maintenance, reproduction, and extension (Brown & Duguid, 2001). While the

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specific terms and categories used by scholars to describe knowledge differ, they generally agree that there is something special about knowledge that enables firms to create value and achieve competitive advantage (Winter, 1987; Kogut and Zander, 1992; Teece, Rumelt, Dosi, and Winter, 1994; Davenport and Prusak, 1998).

The communities of practice phenomenon has been extensively described in qualitative terms, but there has been relatively little research using quantitative techniques, specifically social network analysis. Given the importance of communities of practice, it is important to better understand them and their structural properties. However, quantitative analysis presents challenging issues in part because of difficulties in defining communities of practice. The characteristics of what is considered a community of practice have subtly changed since the term was initially introduced (Lave and Wenger, 1991).

Specifically, the roles of location, functional discipline, and management intention are not clear. Early studies, such as those of copier technicians (Orr, 1996; Brown and Duguid, 1991) and claims processors (Wenger, 1998), depict communities of practice as emergent groups of co-located workers. Workers within communities of practice interact with each other to learn their jobs, address issues, and solve problems. More recent discussions of communities of practice (Wenger et al, 2002) relax these criteria. Distributed communities may now be the norm as new communication technologies enable global communication. Community members may be from different functional disciplines as complex tasks may require cross-functional inputs. Firms may try to create communities. Yet it is unclear if and under what conditions communities of practice can be created.

The goal of this paper is to draw upon common social network analytic measures to determine how the structural characteristics of subgroups of workers defined by job title, functional job group, company division, location, and level of mutual engagement relate to communities of practice theory. Social network measures of connectedness, density, geodesic distance, and core / periphery fit (Schenkel et al, 2001) will be used to assess the groups. This study uses behavioral data from email logs as quantitative measures of community member interaction.

Theory

The term "community of practice" is often casually used to mean everything from those working in the same workgroup to those with the same occupation to those with a common interest. Regardless of whether we are academics or practitioners, we have likely lived in a community at some point in our lives and felt as if we were members of that community. The term is familiar and may even conjure warm memories. The

term practice is also relatively familiar and may bring to mind the idea of a medical practice, a law practice, or children practicing a sport or an instrument. Familiarity with the two terms contributes to the difficulty of a common definition. Those hearing the full expression for the first time will likely have some imprecise conception of the idea based on their experiences. Therefore, a discussion of some of the major works in the communities of practice literature is needed to help clarify the issues.

Communities of Practice

Lave and Wenger (1991) coined the term in their book about learning. Specifically they emphasized the social aspects of learning. They argued that learning was intimately tied to social practice and that learning through apprenticeships occurred via legitimate peripheral participation. Learners begin as peripheral participants (members) of a community of practice. Over time the learners acquire knowledge and skills, and they become recognized by other members of the community as possessing the appropriate knowledge for their community. They work with others to perform their duties and solve problems. As this occurs the learners become more experienced and may move toward being full participants in their community of practice. New members may come and go, or they may come and stay. Others may stay for a while and then move on. As this process occurs repeatedly the community of practice regenerates.

Brown and Duguid (1991), drawing upon Orr's (1996) ethnographic work about copy machine service technicians, link communities of practice to *organizational* learning and innovation. Like Lave and Wenger, Brown and Duguid emphasize the social aspects of learning and depict three aspects of a community of practice: narration, collaboration, and social construction. Narration through story telling helps workers convey problems they have encountered and solutions they have used to rectify the problems, but the stories also serve as knowledge repositories. The collaborative aspect of communities of practice is similar to Kogut and Zander's (1992) combinative capabilities. As workers individually reach the limits of their knowledge and experience, they may collaborate with others to exchange ideas and develop new shared knowledge. Social construction refers to the shared understanding that is developed and constructed by the community members. Members refine their practice and ensure new generations of members by engaging in and contributing to the practices of their communities. Learning, then, is a continuous process of drawing on previous experiences and conceptions of meaning, and incorporating new situations, impressions, and experiences. In doing so members consistently alter their previous understandings.

As appeal for communities of practice grew Wenger more fully developed the community of practice construct (1998). Community and practice are related through mutual engagement, joint enterprise, and a shared repertoire. Community members within and between communities negotiate meaning through the complementary processes of participation and reification. Participation is an inherently social activity. Employees work together and in the process build relationships. They develop routines, tools, and languages specific to their work activities. Through their interactions they develop joint interpretations and solutions to these work activities. Communities of practice are emergent and self-organizing. The complementary process of reification is the process of taking something abstract and representing it in something concrete. These concrete "things" are artifacts and include drawings, procedures, laws, tools, prototypes, spreadsheets, documents, etc.. They enable community members to focus on the artifact to create a greater group understanding. These objects and tools can change how work is performed. Today, many firms use their company intranets to store and disseminate documents.

More recently some of the characteristics of communities of practice seem to have been relaxed. Wenger et al (2002, pg 4) define communities of practice as "groups of people who share a concern, a set of problems, or a passion about a topic, and who deepen their knowledge and expertise in this area by interacting on an ongoing basis." This definition is sufficiently broad to include many different types and sizes of group interaction. Communities of practice can be small or big, co-located or distributed, homogeneous or heterogeneous, spontaneous or intentional, inside and across boundaries (ibid, pg 25). It would seem that these various types of communities would be substantively different from each other and from the original conception of communities of practice. The early exemplars of copier technicians and apprentices described emergent groups of co-located workers with similar jobs. Therefore, this paper seeks to use social network analysis to better understand how these various types of communities of practice differ. Specifically, it investigates the community of practice characteristics of location, functional discipline, and management intention.

Four social network analysis measures (Schenkel et al, 2001) of communities of practice - connectedness, density, core / periphery fit, and geodesic distance – will be used to analyze the different groups. These four network measures were chosen because of their implications relative to communities of practice. Connectedness is the first criteria checked for each group. Members of a community of practice participate with each other in pursuit of a common enterprise; mutual engagement is a key component. Regardless of their type of membership, members within a community are connected either directly or indirectly through other members to all other community of practice members; there should be no isolates.

The second measure calculates geodesic distance - or the shortest path between actors. The geodesic distance is calculated for each dyad and then averaged to determine the average distance among reachable dyads in the group. Learning is the foundation of communities of practice theory. All else being equal, knowledge travels faster when the distance between workers is less. It is therefore expected that communities will have relatively short average distances between dyads.

Density is the third measure calculated. For the valued email matrices, the density is the average cell value or the average number of emails sent. For the dichotomized email matrices, the density is the ratio of the number of actual connections between dyads divided by the number of possible connections. Community members are thought to exhibit strong ties. It is through repeated interactions that trusting relationships develop. It is therefore expected that the density for communities of practice will be relatively high.

Core / periphery fit is the fourth measure calculated (Borgatti and Everett, 1999). Communities of practice contain both core and periphery members. In an ideal core / periphery model core members interact with other core members and with peripheral members. Peripheral members are expected to interact with core members but not with other peripheral members. The fit is determined by comparing the actual interaction matrix with an ideal core / periphery matrix in which the cell values for the core block interactions are ones and the periphery block interactions are zeros. The actual matrix is permuted to position the rows and columns such that the core members and the periphery members are blocked. A correlation is then performed between the actual (permuted) data matrix and the ideal core/periphery matrix. Fit measures will vary between 0 and 1, with a perfect fit being a 1.

In summary, the literature on communities of practice has changed over the past decade such that the roles of location, functional discipline, and management intention are not clear. Community of practice theory suggests that, all else being equal, 1) there will be no isolates, 2) the average distance between workers will be relatively low, 3) community interaction density will be relatively high, and 4) core / periphery fit will be closer to 1. This paper seeks to understand how these structural characteristics differ in communities defined by management intention, location, and functional discipline.

Management Intention vs. Emergence

It is unclear if and under what conditions communities of practice can be created. Wenger (1998) argues that learning cannot be designed and organizations cannot create communities. They can only create the organizational and technical structures that may facilitate a community. The community emerges as members react to that

structure and try to understand and make sense of their environment. Practice is not predetermined by the intended design; it instead emerges as members respond to it. Efforts to create communities may have unintended consequences. In trying to grow a community, the organization may inadvertently hurt it. Yet, many organizations understand the strategic importance of communities and are trying to create them (American Productivity & Quality Center, 2001).

Proposition #1: The structural properties of communities of practice defined by emergence will be positively related to communities of practice theory predictions.

Location

Groups whose members are in relatively close proximity typified communities of practice. Co-location increases the chances of community members meeting face to face. It contributes to spontaneous meetings and encounters in which members can share ideas, problems, and solutions to problems. These repeated interactions allow members to determine what other members know, whom they can trust, and what is expected of them. Traditional face to face meetings provide the richest form of media (Daft and Lengel, 1984). They enable people to see subtle body language gestures that indicate boredom, attentiveness, concurrence, frustration, etc. Rich face to face meetings and interaction enable community members to read these signals. These "messages" are more difficult if not impossible to transmit with less rich media such as the telephone or email. Virtual connections also tend to "lose" people who are not actively participating in the meetings. It is not clear that communities of practice can occur through these virtual connections since the communities are said to emerge from repeated interactions of their members over time (Wenger, 1998; Brown and Duguid, 2000, Cohen and Prusak, 2001). The use of communication technologies may impede the existence of communities of practice.

However, electronic technologies are changing from information posting, database management, and document storage (considered more lean forms of communication) to the richer collaboration and group development that is more consistent with the theory of communities of practice. New communication technologies have brought with them an excitement for the potential connections they can provide across geographies. These technologies vary in their ability to provide connections. Media differ in their ability to process information because of differences in feedback speed, types of cues provided, and language use afforded by the media. Given the appropriate context, the phone, email, and the new advanced technologies may be part of what makes connection and engagement possible. These richer media enable people to communicate and work together across distance and time.

Proposition #2: The structural properties of communities of practice defined by location will be positively related to communities of practice theory predictions.

Functional Discipline

By having practices in common, knowledge travels and is assimilated quickly (Brown and Duguid, 2000). However, it is not clear whether community members have the same type of job. The term practice is not clear. Much of the research on communities of practice refers to those with the same practice as those workers with the same occupation. Brown and Duguid (2001, pg 203) define practice as "undertaking or engaging fully in a task, job, or profession." The inclusion of job and profession in this definition is consistent with the same job function interpretation of communities of practice, but the inclusion of task in the definition leaves open the notion that workers with different occupations may work together to complete a task.

This issue is consistent with the functional / cross-functional issues for technical organizations (Allen 1986, 1977; Van den Bulte and Moenaert, 1998). Managers need to organize to facilitate two types of communication – interdisciplinary and intradisciplinary. Functional expertise is necessary to perform in a quality manner and workers within the same discipline need to connect with each other to keep abreast of the latest technical developments. Functional expertise is communicated and combined by a common language within smaller communities of large complex organizations (Kogut and Zander, 1992). These organizations create knowledge (in part) by combining knowledge within and between groups. Thus, functional organization keeps workers connected to their knowledge base. Conversely, many complex tasks require multidisciplinary inputs. Workers from different professions or jobs must work together (i.e. engage with each other) to complete their tasks. Therefore, cross-functional organization may lead to more effective communication.

> Proposition #3: The structural properties of communities of practice defined by functional discipline will be positively related to communities of practice theory predictions.

This paper uses social network analysis to investigate the structural characteristics of different subgroups within a firm. It is an exploratory study that uses four commonly used network measures (connectedness, density, core / periphery fit, and geodesic distance) on subgroups to determine which subgroupings most closely align with the communities of practice theory. The workers' job titles, job groups, divisional assignments, location, and hierarchical clustering of their dyadic interaction patterns define the subgroups.

Data

Data for this study are taken from email logs at the U.S. headquarters location of a global specialty chemicals firm. This firm has less than 1000 employees.

Communities of practice theory rests upon social interaction and mutual engagement by the workers. Email logs record employees participating with each other. The log data include the date, time, sender, and receiver(s) of each email. The data are transformed into square interaction matrices that are valued and directional. The email data are from the month of June 2002 and include the emailing behavior of 146 employees. This results in a sample size of 21170 interactions for the full group; the diagonals are ignored. Much of the analyses are performed on subgroups of these 146 employees.

Privacy concerns invariably arise when discussing email logs as a source of archival data. This issue was discussed with company personnel to better understand the company's privacy policy. Before receiving computer system user accounts and hardware, all U.S. employees at this firm are required to sign a form in which they acknowledge that 1) all data and messages are company property, 2) the employees have no rights or expectations of privacy, and 3) the company has the right to review, audit, and access all matters on the company's communication systems regardless of content or intended source. This policy implicitly allows for the use of logs to perform social network analysis. While analysis of email content would be allowed by this policy, the content of the emails was not used during the course of this study (nor was it in the logs or available to the researchers), which minimizes the impact on privacy. Additionally, this study only investigated the communications within the firm; no external email traffic was analyzed.

Not knowing the content of the emails is a double-edged sword. It protects privacy, but it may lead to suspicion of email interactions as an appropriate measure for community of practice interactions. Email can include jokes or important personnel decisions and each would count the same using the interaction as the unit of analysis – as one interaction. However, the communities of practice literature stresses the importance of water cooler talk and lunch time conversations in building trust; emailing jokes can be argued to be analogous to that water cooler talk. Additionally, previous research has shown that dyadic level emailing interaction is positively related to telephone interactions and proximity (Koku et al, 2000), where proximity was a measure for face to face interactions (Allatta, working).

The technology system logs are advantageous as a source of archival data for a number of reasons. First they do not suffer from low survey response rates; information for all workers in the system is collected. Second, the data are automatically collected and stored. They do not require the time and expense of having employees fill out surveys, nor the time and expense of the researcher to followup. And third, they provide an accurate record of worker behavior and are therefore not subject to the retrospective rationalization of the researcher or faulty memory of the worker being surveyed.

Individual and organizational attribute data were extracted from the company's human resources (HR) database. These data included demographic information such as job title, division, tenure at the company, gender, and birth date for each worker. Office maps were used to determine worker locations. There are two office buildings on this property. Office maps were available for only one of the buildings. Four major areas were identified for this building and workers were assigned to one of those areas based upon the section of the building in which their office was located. The forty-five workers located in the other building for which no map was available were assigned to one aggregated location.

Data for *subgroups* of workers were extracted from the overall sample of 146 employees based upon their job title, their job group, their divisional assignment, their work location, and the results of hierarchical clustering of the email matrix. The division category was included to serve as groups defined by management intention. The firm's top management team heads each division and employees report up through their divisions. There are seven divisions, but the vast majority of workers in our sample (140 of 146) are in five of these divisions. The location category is considered separately for theoretical reasons; however the firm's management team also determined worker office locations. Two months before these data were collected 101 of the 146 employees moved from one building to another due to renovations. (No office location map is available for worker offices before the move.) Interviews with employees indicate that many employees, who were co-located before the move, were also co-located after the move. However, management changed some employee groupings to facilitate better communication based on business processes. Correlation analysis between worker location and various employee attributes yields a significantly high correlation between location and job group. Job groups are job classifications such as 'information systems' or 'research and development'; they are not part of the management structure. Workers with different job titles may be in the same job group. For example, the R&D job group includes chemists, secretaries, technicians, etc. The hierarchical cluster grouping, based upon email interactions, was included to serve as emergent groups. The clustering is based upon behavioral data and reflects both the informal and formal communications between workers.

The original interaction matrix contained valued email sending and receiving data for the 146 employees for a one month time period. This matrix was then dichotomized three times using three different criteria. The first criterion was simple dichotomization of the data to make all cell values greater than zero (GT0) equal to one, else the cell values equaled zero. The second criterion was to make all cell values greater than one (GT1) equal to one, else the cell values equaled zero. This was done to remove the weakest ties. The third criterion was to make all cell values

greater than four (GT4) equal to one, else the cell values equaled zero. This was done to obtain the stronger ties such that there was, on average, at least one interaction per week. Subgroup data (determined from job title, job group, division, location, and hierarchical cluster) were then extracted from each of these three dichotomized matrices. The four previously detailed social network measures were then calculated for each of the three dichotomized matrices for each subgroup. UCINET 6 (Borgatti, Everett, and Freeman, 2002) and NetDraw (Borgatti, 2002) were the software packages used to analyze the network data.

Results

Table 1 summarizes the basic statistics for the email interaction data for the overall group of 146 employees and the fifteen subgroups. The job title subgroups were chosen to maximize the number of workers. Of the 146 workers in the sample, 49 of them have unique job titles. Therefore the size of the groups defined by job title is relatively small. The minimum, maximum, average, standard deviation, and sum of the interactions is listed for each subgroup. The isolates show the number of workers who are not connected to any other member of the group. The number of groups indicates the number of separate subgroups within that category. For example, of the 12 chemists there are 2 chemists who are not connected to any other chemists; they are isolates. The remaining 10 chemists are split into 2 separate subgroups of chemists (see figure 1). The average graph theoretic distance is the average geodesic distance among those workers who can reach each other.
Results for the dichotomized data (greater than 0) are shown in Table 2. The number of workers in each subgroup is shown again for reference. Table 2 summarizes the results and provides the density, distance, and core / periphery fit *averages* for each subgroup category. Since there is no established database to determine acceptable values for communities of practice, the average values are evaluated (i.e. ranked) relative to the other values to determine which most closely align with communities of practice theory. The community type that is highest in density, lowest in distance, and closest to 1 for core/periphery fit is ranked first for that structural category. Figure 2 graphically represents the ranks of each group category for each structural measure. Table 2 and Figure 2 reveal that the hierarchical cluster category has the highest average density (0.605), lowest average distance (1.391), and second highest average core / periphery fit (0.518). Therefore, it ranks first for density and distance, and second for core / periphery fit. None of the three hierarchical cluster subgroups has isolates.

	#	Description	# Workers	Min	Max	Average	Std Dev	Sum	Isolates	Groups	Ave Graph Theoretic Distance
HQ		Headquarters	146	0	277	0.6645	3.4024	14068	1	1	1.911
Job Title	1	Chemist	12	0	2	0.0985	0.3451	13	2	2	1.682
	2	Customer Service	7	0	12	1.5714	2.1618	66	1	1	1.200
	3	Product Manager I	6	0	14	2.1000	2.9366	63	0	1	1.367
Job Group	1	R&D	44	0	27	0.6982	2.4098	1321	0	1	2.175
	2	Information Systems	12	0	54	3.2424	7.6020	428	0	1	1.402
	3	Marketing	7	0	42	4.7381	8.3753	199	0	1	1.738
Division	1	Sales & Marketing 2	34	0	32	1.3449	3.6895	1509	0	1	1.913
	2	Production, Mfg, Purchasing	22	0	277	2.9502	15.6569	1363	0	1	1.654
	3	Finance & Info Technology	31	0	54	1.9849	5.2267	1846	0	1	1.682
Location	1	Location 1	45	0	75	0.8995	3.0865	1781	0	1	1.964
	2	Location 4	28	0	42	1.6376	4.3563	1238	0	1	1.823
	3	Location 3	17	0	54	4.1544	8.5877	1130	0	1	1.391
Cluster	9	HCluster9	16	0	54	4.5500	9.1176	1092	0	1	1.436
	11	HCluster11	8	0	31	4.5893	7.2130	257	0	1	1.321
	12	HCluster12	19	0	41	3.4123	6.0294	1167	0	1	1.415

Table 1: Basic Statistics – Email Interaction Data

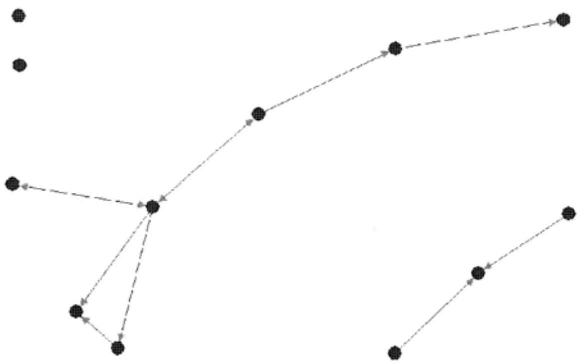
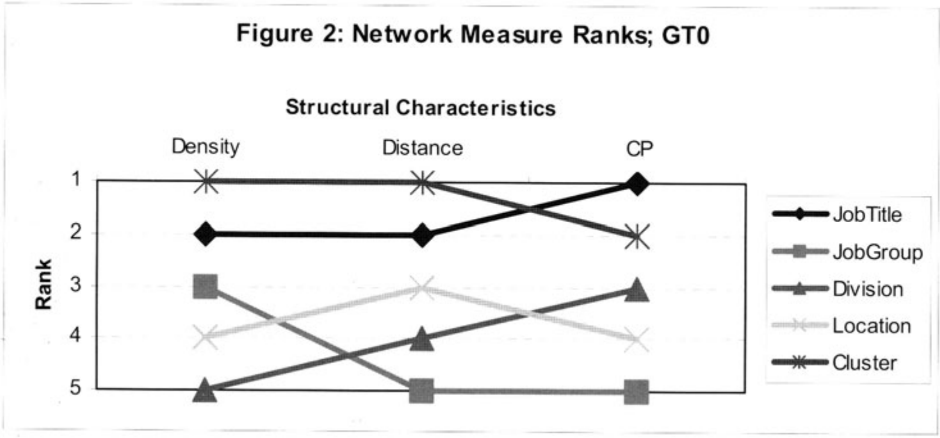


Figure 1: Job Title Group – Chemists: 2 Isolates, 2 Subgroups

	#	Description	N Workers	Isolates	Groups	Average Density	Rank: Average Density	Average - Ave Graph Theoretic Distance	Rank: Average - Ave Graph Theoretic Distance	Average - Core / Periphery Structure	Rank: Average - Core / Periphery Structure
HQ		Headquarters	146	1	1						
Job Title	1	Chemist	12	2	2	0.440	2	1.416	2	**0.562**	**1**
	2	Customer Service	7	1	1						
	3	Product Manager I	6	0	1						
Job Group	1	R&D	44	0	1	0.432	3	1.772	5	0.325	5
	2	Information Systems	12	0	1						
	3	Marketing	7	0	1						
Division	1	Sales & Mktg 2	34	0	1	0.351	5	1.750	4	0.476	3
	2	Production, Mfg, Purch'g	22	0	1						
	3	Finance & IT	31	0	1						
Location	1	Location 1	45	0	1	0.382	4	1.726	3	0.467	4
	2	Location 4	28	0	1						
	3	Location 3	17	0	1						
Cluster	9	HCluster9	16	0	1	**0.605**	**1**	**1.391**	**1**	0.518	2
	11	HCluster11	8	0	1						
	12	HCluster12	19	0	1						

Table 2: Email – Dichotomized, greater than 0: Network measure averages and ranks



The job title category has the second highest average desity (0.440), second lowest distance (1.416), and highest average core / periphery fit (0.562). Two of the three job title subgroups have isolates, and one splits into two groups.

Tables similar to Table 2 were calculated for the dichotomized (greater than 1 and greater than 4) data. The resulting ranks are summarized in Figures 3 and 4. Figure 3 details the results of the dichotomized matrices that remove the weakest ties. The hierarchical cluster category ranks first in density, and second in distance and core / periphery fit. None of the 3 subgroups have isolates. The job title category ranks third in density, and first in distance and fit. Again, two of the job title subgroups have isolates and one has two separate groups.

Figure 3: Network Measure Ranks; GT1

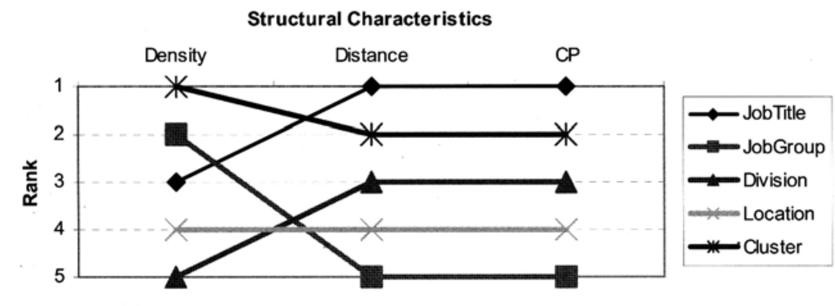


Figure 4: Network Measure Ranks; GT4

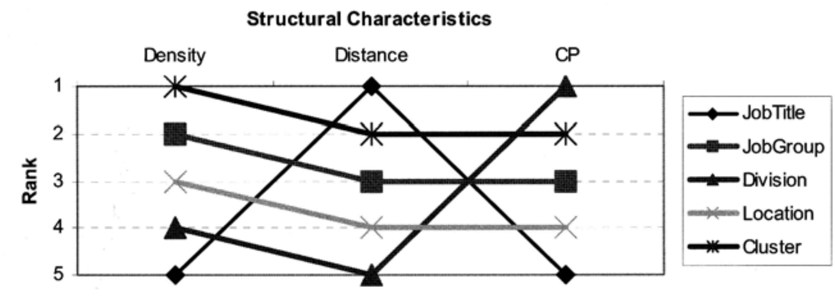


Figure 4 has the results of the dichotomized matrix with the stronger ties – those that are at least weekly interactions. The cluster category again ranks highest in density and second in distance and core / periphery fit. The job title category ranks

first in distance, but last in density and core / periphery fit. All three job title subgroups have isolates with the chemist being totally disconnected. The job title, job group, division, and location categories all contain subgroups with isolates. The marketing job group and the sales and marketing division each have split into further subgroups.

The impact of group size (number of employees) on the network measures requires discussion. Inspection of the sizes of the hierarchically clustered and job title groups reveals that these categories of groups tend to have fewer employees than the other groups such that it might be size that accounts for the difference in network measures. This prompted further analysis of the data based on size. The data were grouped by size of the subgroups and averages of the network measures were again calculated.

	#	Description	N Workers	Isolates	Groups	Average Density	Rank: Average Density	Average - Ave Graph Theoretic Distance	Rank: Average - Ave Graph Theoretic Distance	Average - Core / Periphery Structure	Rank: Average - Core / Periphery Structure
Job Title	3	Product Manager I	6	0	1	**0.604**	**1**	**1.407**	**1**	0.465	2
Job Title	2	Customer Service	7	1	1						
Job Group	3	Marketing	7	0	1						
Cluster	11	HCluster11	8	0	1						
Job Title	1	Chemist	12	2	2	0.480	2	1.465	2	**0.501**	**1**
Job Group	2	Information Systems	12	0	1						
Cluster	9	HCluster9	16	0	1						
Location	3	Location 3	17	0	1						
Cluster	12	HCluster12	19	0	1						
Division	2	Production, Mfg, Purchasing	22	0	1	0.345	3	1.768	3	0.421	4
Location	2	Location 4	28	0	1						
Division	3	Finance & IT	31	0	1						
Division	1	Sales & Mktg 2	34	0	1						
Job Group	1	R&D	44	0	1	0.205	4	2.017	4	0.458	3
Location	1	Location 1	45	0	1						
HQ		Headquarters	146	1	1						

Table 3: Group Size Analysis: GT0 : Email – Dichotomized, greater than 0: Network measure averages and ranks

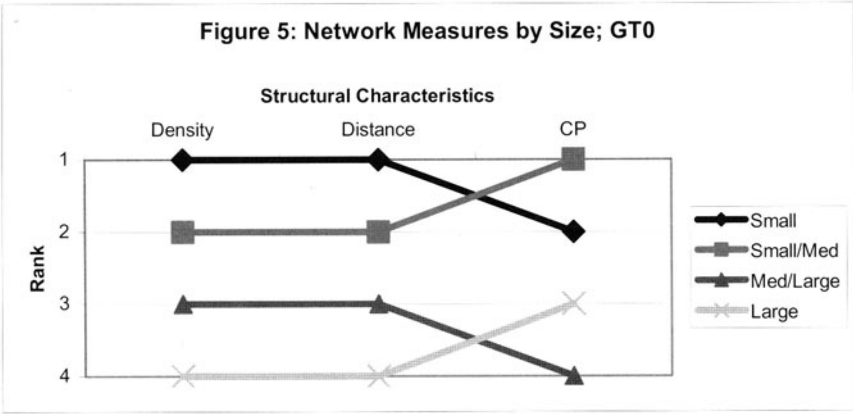


Figure 5: Network Measures by Size; GT0
Structural Characteristics
Density
Distance
CP
Rank
1
2
3
4
Small
Small/Med
Med/Large
Large

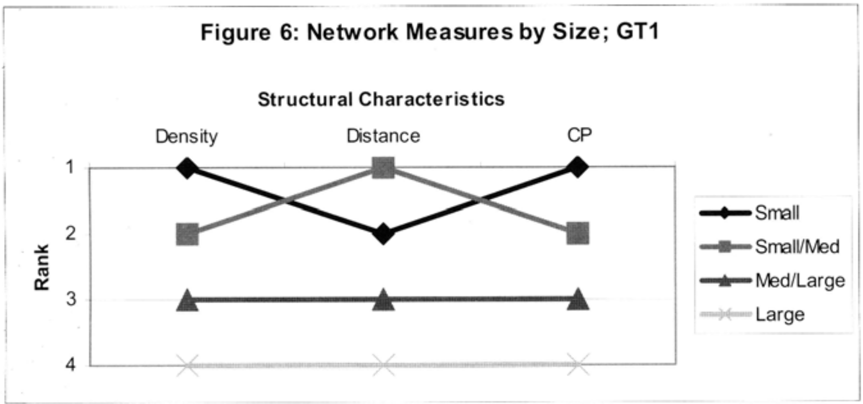


Figure 6: Network Measures by Size; GT1
Structural Characteristics
Density
Distance
CP
Rank
1
2
3
4
Small
Small/Med
Med/Large
Large

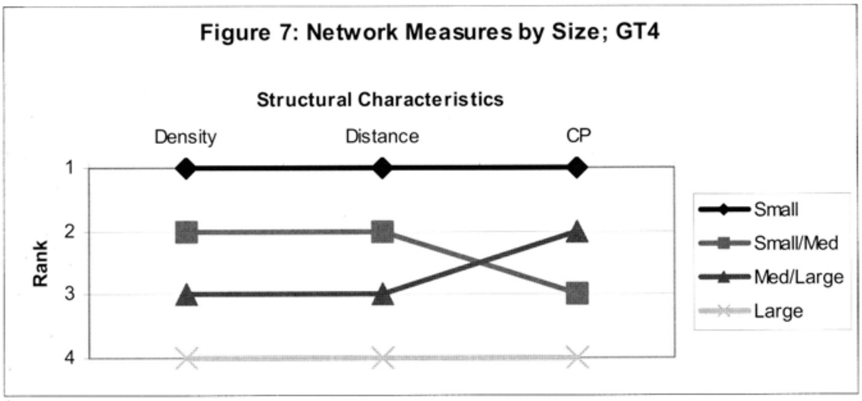


Figure 7: Network Measures by Size; GT4
Structural Characteristics
Density
Distance
CP
Rank
1
2
3
4
Small
Small/Med
Med/Large
Large

Table 3 details the results of the average values and their ranks of the network measures when the categories were determined based on size of the group. Table 5 and Figure 5 detail the results of the matrices dichotomized by values greater than 0. Figure 6 details the results with the weakest ties removed – data dichotomized by values greater than 1. Figure 7 shows the results with the stronger ties – data dichotomized by values greater than 4. All three figures reveal a consistent relationship between size and the network measures. The smaller groups are higher in density and core periphery fit, and lower in average geodesic distance.

Discussion

Knowing where knowledge in a firm is located is important because transferring and combining knowledge within and across groups can lead to value creation (Nohria and Ghoshal, 1997). Firms may benefit by applying their knowledge from one area into other related areas, from one group into other related groups, or from one business into other related businesses. Because knowledge is thought to reside in communities of practice, this study used social network analysis to analyze groups of workers with different characteristics to determine how their network measures related to community of practice theory.

The goal of this study was to better understand three characteristics of communities of practice: job title, location, and management intention. Four common network measures (connectedness, density, geodesic distance, and core / periphery fit) were calculated for various subgroups of workers defined by job title, job group, division, location, and hierarchical cluster. Theory would suggest that the density and core / periphery fit values should be high, while the average geodesic distance should be low for communities of practice. There should also be no isolates or subgroups. It was argued earlier that the roles of job title, location, and management intention are not clear in the communities of practice literature. These results support proposition 1 and suggest that emergent groups defined by actual interaction patterns (i.e. hierarchically clustered) match the communities of practice structural theory more closely than those defined by management intention. The structural characteristics of the clustered groups reflect communities of practice theory to a greater extent than do the groups defined by division and job group. The structural characteristics for job title are mixed. Many of the job title results ranked highest, but there were also more isolates and subgroups with this category. This requires further investigation.

Size of the group plays a part in the results of the structural analysis. Wenger et al (2002) allow for hundreds, even thousands of community members, especially for distributed communities. However, maintaining relationships takes time and energy

and it is not possible to maintain repeated ties with large numbers of others. The nature of the relationships among members of a community will change as size increases. It is expected that larger communities will divide into subgroups by subject or location because there are costs associated with creating and maintaining ties as well as with transferring knowledge. It is reasonable then to expect that density will decrease and average geodesic distance will increase as group size increases. The core / periphery fit would also be expected to decrease as the larger groups split into smaller sub-groups.

Brown and Duguid's (2000) distinction between communities of practice and networks of practice proves useful here. Connections between members of a network of practice are looser than between those in a community; many people in a network may not even know or know of others in the network. For example, bus drivers in San Francisco do not belong to the same community as bus drivers in Buffalo, but they may belong to the same network of practice. It is through close ties and working directly with each other that people belong to the same community. A community involves people working, interacting, and interpreting together. Bus drivers from a specific area will be from the same community because they work together to cover routes, get around traffic jams, and deal with the public.

Disentangling size from the five categories of job title, job group, division, location, and cluster requires further investigation. For this data set there is relatively small variation of the group sizes within the categories and relatively large variation of the group sizes between the categories. Job title groups are only of small size. With the exception of the R&D job group, job groups are only of small size. Divisions are only of medium size; locations are of medium to large sizes; and hierarchical clusters are of small to medium sizes. Current analyses are being performed to further investigate the relationship between group size and the structural measures of the subgroups in this dataset. Future work will include vector analysis of website hit patterns to examine other types of communities of practice.

Conclusion and Future Work

Given the social nature of knowledge, the dispersion of many knowledge and information workers, and the impediments to learning, understanding how employees communicate within their communities of practice becomes important. In today's global environment, firms must be able to draw upon their knowledge resources in all locations in order to innovate and create knowledge, thereby creating value (Nohria and Ghoshal, 1997). They cannot remain competitive solely by appropriating the benefits of innovation from one location into other locations. This research seeks to

contribute to the understanding of the characteristics of communities of practice and the nature of the work performed.

This paper argued that the roles of job title, location, and management intention were unclear in the current communities of practice literature. The study used the common social network measures of connectedness, density, graph theoretic distance, and core / periphery fit of various groups of communities of practice as defined by job title, location, and management intention and determined how these measure aligned with community of practice theory. Initial results from this work suggest that grouping employees by their informal communications (hierarchical clustering of their interactions) yields network measures that are most closely related to community of practice theory. The network measures for management-defined groups (division) rank lower. This is consistent with the theory that communities of practice are emergent structures, not structures defined by management. The network measures for job title are mixed. The job title network measures rank relatively high compared with the other methods of grouping, but these groups also tended to have more isolates and subgroups. The network measures for location rank in the middle to lower range.

Group size seems to be confounded with group categories in this data set. Work is currently being performed to further analyze this relationship with this data. Future work will investigate other types of communities of practice using vector analysis of company intranet hits.

Acknowledgments

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Episteme or practice? Differentiated Communitarian Structures in a Biology Laboratory

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Abstract. This paper explores the different social structures coexisting within a biology laboratory. This work draws upon an empirical study and the results are analysed using the social network analysis toolbox. We evidence that actors form links between them in order to carry out cognitive activities. Depending on the content of this activity, resulting networks can take different shapes. When dealing with scientific knowledge, actors tend to form an epistemic community, whereas they form a community of practice when they seek to enhance their skills in setting experiments. Moreover, these two structures are connected by means of boundary objects and boundary spanners.

Introduction

Communities have recently become a prominent unit of analysis for understanding knowledge exploration, sharing and transmission in and among organizations [Bowles and Gintis, 2000]. "By community we mean a group of people who interact directly, frequently and in multi-faceted ways. People who work together are usually communities in this sense, as are some neighborhoods, groups of friends, professional and business networks, gangs, and sports leagues.

M. Huysman et al. (eds.), Communities and Technologies, 43-63.

The list suggests that connection, not affection, is the defining characteristic of a community" [Bowles and Gintis, 2000: 3].

As links within the communities are specific, and more tightly defined than with the environment, this notion proved especially relevant to understand to learning and knowledge creation. Indeed, communities understood as specific governance structures are deemed particularly relevant to coordinate collective knowledge creation efforts. Communities articulate tacit, fuzzy, ever-moving information flows and knowledge.

However, there is no such thing as 'the' community with specific, clear and characteristic features. The recent surge in the literature on studies of communities put emphasis on multiple various aspects of their organization, management, boundary dynamics and social relationships [Bowles and Gintis, 2000]. Communities of practice [Lave and Wenger, 1990], epistemic communities [Knorr Cetina, 1999], virtual communities [Alstyne and Brynjolfsson, 1996], communities of creation [Sawney and Prandelli, 2000], strategic communities [Stork, 2000], among others, all these communities might populate diverse organizational contexts.

This paper contends that there is a strong need to clarify what is called organizational community and what are the main characteristics of diverse communities. Especially, this paper attempts to distinguish and relate the two notions of epistemic community and community of practice. We chose to focus on these two notions for two reasons. First, there is a stronger field of the literatures devoted to them than to the other ones. Second, these communities are explicitly knowledge-intensive[1]. Moreover, the proximities and distances between these two notions have not yet been thoroughly investigated. This paper therefore aims at differentiating and relating epistemic communities (ECs) and communities of practice (COPs).

Based on a case study carried out in a French biology laboratory, analysis was twofold. First, we distinguish the two types of community, namely EC and COP. We claim that both kinds of communities contribute to knowledge creation and maintenance, but that they display distinctive features in terms of their social structures, the type of knowledge they handle and their activities. Second, we put forward that knowledge creation occurring within the laboratory as a whole stems from the interplay between these two structures.

This paper is organized as follows. First, we theoretically present the notion of community and then we detail epistemic communities and communities of practice. The next section is devoted to the methodology of this research. Then, the 'LAB' case study is described. Next, using social network analysis, we draw two social structures that advance the understanding of the distinction between

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[1] We do not address the case of virtual communities, since the concept encompasses a large diversity of realities: many virtual communities are not concerned by learning or knowledge creation and therefore fall out of the scope of this paper.

epistemic community and community of practice. We finally try to understand how these two structures are intertwined and what are the outcomes of this interplay.

A first step toward the disentanglement of organizational communities

Many forms of communities can be identified within the literature, both in the realm of economics and of management studies. Given this diversity, authors have decided to focus on cognitive communities, that is, communities engaged in one way or another in knowledge creation processes, and even more precisely on two specific kinds of cognitive communities deemed to be the most relevant in terms of creation of knowledge "as usual" within the firm. It is, however, possible to lay out some important features common to many types of cognitive communities one can find in the literature.

Cognitive communities share a common ground that differentiates them from other types of communities (e.g. communities of interest, social communities, etc.). Cognitive communities rely on myriad of interactions between individuals sharing a common cognitive objective. Their commitment to this objective is paramount for it determines the degree of members' involvement in the collective thrive of the community.

Epistemic communities and communities of practice are the most relevant types of groups for the purpose of this paper, since they are the place where knowledge creation occurs on a regular basis, independently of any hierarchical decision. The key point, within the scope of this paper is that epistemic communities are truly oriented toward new knowledge creation, whereas communities of practice are oriented toward the achievement of an activity. In this latter case, knowledge creation is an unintended spill-over.

Epistemic Communities

Epistemic communities can be defined as small groups of "agents working on a commonly acknowledged subset of knowledge issues and who at the very least accept a commonly understood procedural authority as essential to the success of their knowledge activities" [Cowan et al., 1998]. Epistemic communities can thus be defined as a group of agents sharing a common goal of knowledge creation and a common framework allowing the shared understanding of this trend. The goal of epistemic communities is thus simultaneously outside and above the community's members. The concept of "epistemic communities" was developed in particular in the realm of international relations [Haas, 1992; Adler and Haas, 1992]. Using this concept to address the issue of codification of knowledge,

Cowan et al. [1998] suggest that any codification activity implies the existence of codes that are understandable by the communicating actors.

What defines an epistemic community is thus the existence of a procedural authority that can be explicit or not. However, it must be different from the kind of authority held by a "guru" to ensure certain autonomy of the members. Moreover, the procedural authority conveys the idea of progress toward the cognitive goal set by the community. The belonging of members will thus be evaluated with respect to this procedural authority. It should be noted that this procedural authority could a priori emerge from the interactions among members. In that case, the organizational closure is either realized, or imposed from the outside and then not realized. In the former case, the epistemic community is self-organized and then close in this respect to a community of practice. This remark is important since it shows evidence of the possibility for one form of community to evolve into the other.

Epistemic communities are structured around a goal to be reached and a procedural authority endowed by themselves (or with which they were endowed) to fulfill that goal. Notions of autonomy and identity are thus weaker than in the case of communities of practice (see below), thus favoring the group's creativity [Leonard-Barton, 1995]. Thus, the community increases its ability to seize future opportunities. This form of organization spawns knowledge creation by favoring the synergy of individual varieties. We find here the principle of "required variety" stated by Ashby [1956]. Individuals accumulate knowledge according to their own experiences. The quality of this knowledge depends on two factors. The first is the variety of individual experiences in interaction. The second factor is the "knowledge of the experience". This is consistent with the idea of a rational ability of experience feedback within which the validation is made according to the procedural authority: what is evaluated is the contribution of the agent to the cognitive goal with regard to the criteria set by the procedural authority.

Because of the heterogeneity of the agents, the objective of knowledge creation for the sake of knowledge, the first task of epistemic communities is to create a "codebook". Hence, knowledge circulating within epistemic communities is explicit (but not codified since it remains mainly internal to the community [Baumard, 1999]. Because of the lack of deeply shared values, it appears that the knowledge creation mode is much like a form of externalization (conversion of tacit into explicit knowledge [Nonaka and Takeuchi, 1995].

Knowledge creation is certainly the main goal of epistemic communities is knowledge creation. However, this goal is itself subordinated to another one: convincing the outer world that the position it holds is right.

Validation of the cognitive activity of an agent is made with respect to the procedural authority. What is evaluated is the contribution to the endeavor toward the goal to be reached, according to the criteria set within the procedural authority. Within an epistemic community, agents are bound together by their

commitment to enhance a particular set of knowledge. The recruitment rule is thus defined with regard to the contribution an agent makes to fulfill this goal (this goal is likely to be partly given and partly emergent [Blackler and McDonald, 2000])[2].

Communities of Practice

The concept of communities of practice was introduced by Lave and Wenger [1991] who, by focusing on individuals' practices, identified groups of persons engaged in the same practice, communicating regularly with one another about their activities. Members of a community of practice essentially seek to develop their competencies in the practice considered. Communities of practice can then be seen as a means to enhance individual competencies, they are oriented toward their members [Lave and Wenger, 1991; Brown and Duguid, 1991]. This goal is reached through the construction, the exchange and the sharing of a common repertoire of resources [Wenger, 1998].

Wenger [1998] and Brown and Duguid [1991; 1998] state that self-organization is an essential characteristic of communities of practice. According to Lesourne [1991], self-organization is the ability of a system to acquire new properties by organizing itself or by modifying by itself its own organization [Lesourne, 1991]. Self-organization confers to the system an adaptive ability to evolve without any constraint of authority nor any determinism. The system is then autonomous and sets a boundary with respect to the other functions of the firm. It creates a sort of "organizational closure" in the terminology of the theory of self-organization. This idea is important since it underlines the cross functional nature of communities of practice.

More precisely, autonomy and identity of communities, the key characteristics of self-organization allow the collective acquisition and processing of stimuli from the environment [Wenger, 1998; Dibiaggio, 1998]. Identity and autonomy are essential for the agent to define herself with respect to her environment and for the members of the community to behave collectively.

The self-consciousness is also visible in the mutual commitment of the community. It is built around activities commonly understood and continually renegotiated by its members. A community's member feeds it with her experience and, in turn, relies on the knowledge capitalized by the community to carry out her activity. These processes take the shape of "war stories" [Brown and Duguid, 1998] that members tell when they gather. They thus develop a jargon understandable by the members only. It is thus a mutual commitment that binds

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2 Epistemic communities emerge in uncertain context calling for the creation of a new paradigm (which is not the case for communities of practice) [Haas, 1992; Whiteneck, 1996]. We are then close to the community of young researchers overcoming the old paradigm in Kuhn's theory [1962].

agents in a social entity, ensure cohesion of the community and recruitment of new members.

Lave and Wenger [1991] interpret the practice of these communities as the vector of learning, which is in turn the building of an individual entity. Hence, the evaluation of an individual is made by the community of practice as a system and is focused both on the values adopted by the individual and on the progress made in her practice, the two being co-constitutive.

This implies that members of a community of practice do not all contribute in the same manner to the cognitive activities [Wenger et al., 2002]. At the heart of a community of practice lies a hard core made of one or few coordinators. Around them, active collaborators constitute the first level of participation. The second degree is made of more peripheral actors, participating in the activity of the community but at a lower degree of commitment.

Within communities of practice, the privileged knowledge is thus essentially the know-how [Brown and Duguid, 1991], which is tacit and socially localized. The nature of knowledge is due to the objective and the structure of the communities of practice. As a result, the community tends to send no messages toward the outer world. Messages are almost exclusively exchanged among the members of such a community.

Objectives of this research

This research aims at differentiating and relating the notions of epistemic community (EC) and community of practice (COP). It endeavors to determine whether or not they correspond to distinct realms of organizational life and to understand how agents relate to these two kinds of structuring. It seeks to develop general propositions regarding the separation and relation between the two kinds of communities. Such conceptual distinction is important on theoretical as well as on applied grounds.

Theoretically, attempting to untangle ECs and COPs is necessary to determine whether there should be two different concepts. Moreover, if epistemic communities and communities of practice concern aspects of organizing that partially overlap, it becomes relevant to examine what makes them close and yet different.

On the more practical side, questionings multiply today as to how to support communities in organizations. If there are deep differences among communities, then these distinct groups should require different ways to be encouraged and managed and these ways might be inconsistent. Differentiating and relating epistemic communities and communities of practice could therefore prove useful to make explicit their respective managerial challenges and suggest paths to support them.

In order to differentiate and relate ECs and COPs, this research investigated the social structure(s) of a specific group that could a priori be indifferently considered as an ideal context for EC and COP. The structural analysis sought to determine if the two communities emerged, in which regards they were different and how members of these two communities acted in relation to one and / or the other one.

Methodology

Research design and choice of the research setting

We chose to study a single field, a biology laboratory, henceforth called 'the LAB'. The single case research design made it possible to deeply investigate the field and to underscore its collective processes and structuring. In particular, we needed to access the main work practices as well as the internal and external relationships of a group whose features were close to organizational communitarian ones.

Of course, as communities are informal groups that do not have clear and fixed boundaries, we could not be sure before investigating it that the studied context was a community. The fuzzy nature of communities made it especially important to distinguish field characteristics that encourage the emergence of communities. The criteria we selected concerned the size, the location, organization and overall mission of the field (cf. table 1). None of them independently warranted the presence of communities, but their coincidence made us presume of a community-friendly environment.

Criteria	**Presumption of community-friendly environment**	**LAB's case**
Size	*Small size*: Most members know each other.	13 members in the LAB.
Location	*Collocation*: Members interact on a daily basis.	All LAB members work full-time in the same building.
Organization	*Common overall activity* and preeminence of an informal organization.	All LAB members work in the same field of activity, in genetic biology.

Table 1: A community-friendly environment

Moreover, in order to examine the potential differences and similarities between epistemic communities and communities of practice, the field was to present potential characteristics of both kinds of communities. We selected this

case because, according to its members' practices *and* knowledge basis, it could be interpreted both as a community of practice and as an epistemic community (cf. table 2), with no way to label it a priori nor exclusively one way or the other.

	Community of practice	**Epistemic community**
Attributes	Group whose members develop close work practices, for some similar and for some complementary.	Group devoted to the advancement of specific knowledge, for instance scientific.
Example from the literature	Copiers' repairers [Orr, 1996]	Physicians from [Knorr Cetina, 1999]
LAB's case	LAB's members worked closely and on the same machines.	LAB's members devoted to the advancement of genetic biology.

Table 2: Epistemic communities and communities of practice: empirical attributes

Data collection and analysis

To get a simultaneously broad and fine-grained vision of the LAB's organization, we triangulated diverse sources of observations. One of the authors became a participant observer in the field. While these day-long sessions of participant observation over a period of two months were not sufficient a truly dynamic understanding of the case, they made us reasonably acquainted with the idiosyncrasies of the context. In addition to this participant observation, we also consulted the archives of the LAB as well as its bibliographical and patents records. Finally, all LAB's members were semi-structured interviewed. Interviews lasted from 45 minutes to 2 hours. They were tape-recorded and transcribed. Conversations concerned the ways LAB's members worked, interacted and exchanged on a daily basis. These diverse qualitative sources of observations were fused to describe the case study presented below.

We complemented this first exploratory stage of the case by systematizing the interviews' analysis. From each interviewee's transcripts we extracted the main relationships the agents' had with her or his colleagues to draw the overall network of communications[3]. Then, we distinguished between two types of relationships (respectively involving exchanges regarding the making of experiments or scientific advancement). Such distinction represented a mean for us to try to distinguish, and then analyze, the two potential kinds of communities. The results of this empirical work are presented below.

[3] We used the R software [Ihaka and Gentleman, 1996].

The LAB's case study

The LAB (officially called Laboratory of Viral Genetics and Biosecurity) is a small research center located in a French rural region geographically close to two universities, U1 and U2. The LAB is related to a 'zoo-hub', local association of research centers and agricultural firms devoted to the improvement of animals (especially bovines and chicks)' health.

Members of the LAB investigate two main sets of themes. Some researchers work on determining the genome of emerging viruses and on evaluating their biosecurity. Others study viral and plasmatic vaccine vectors. Most financial support of the LAB's activity comes from the parent institution (the AFSSA) and from research programs sponsored by various institutions. In particular, the LAB depends on research programs financed by the INSERM[4] and by the European Union. At the time of this study (mid- 2002), thirteen people (scientists, technicians and one administrative person) work full-time for the LAB. They all institutionally belong to the AFSSA.

Name	**Status**	**Scientist / Technician**	**Length of service[5]**	**Type of contract**
André	Research director	Scientist	18 years	Permanent contract
Patrick	Research director	Scientist	10 years	Permanent contract
Philippe	Qualified technician	Technician / sc	18 years	Permanent contract
Claire	Qualified technician	Technician / sc	10 years	Permanent contract
Yannick	Post-doc	Scientist	3 months	Fixed-term contract: 36 months
Christophe	Post-doc	Scientist	2 months	Fixed-term contract: 18 months
Daniel	Post-doc	Scientist	1 month	Fixed-term contract: 18 months
Frédéric	Doctoral student	Scientist	4 months	Fixed-term contract: 36 months
Véronique	Qualified technician	Technician	1 year	Fixed-term contract: 24 months
Aurélie	Qualified technician	Technician	6 months	Fixed-term contract: 12 months
Annie	Technician	Technician	18 years	Permanent contract
Renée	Technician	Technician	4 years	Permanent contract
Ludovic	Administrative assistant	NA	6 months	Permanent contract

Table 3: LAB's members

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[4] INSERM: Institut National de la Santé Et de la Recherche Médicale (National Institute of Health And Medical research).

[5] Length of service at the moment of investigations (April / May 2002).

Because of the lack of permanent financial resources of the laboratory, most scientists are hired on a fixed-term contract basis. On the other hand, most technicians are hired on a permanent basis. They have been working for a longer period than the scientists and they know that they will stay there for more than one or two years.

The laboratory is organized around its main research projects. At the time of investigations, the scientists are devoted to three main projects. The first one, directed by Patrick, concerns the genome of an emerging virus affecting bovines (let us call it emerging virus), while the two others, supervised by André, treat viral and plasmatic vaccine vectors (henceforward named Vaccine vector 1 and 2). The newly arrived scientists (2 post docs and a doctoral student), according to their previous works and their competencies, were hired by the concerned research directors to pursue these research projects. The third post-doc (Yannick) was hired to work part time on one research project (Vaccine Vector 1, with Daniel) and to develop his own project of implementation of a bio-informatics software in the center. Yannick who has a double competence, as a scientist and as a computing specialist in bio-informatics, was conjointly hired by the LAB and by the local zoo-hub.

	Emerging virus	**Vaccine Vector 1**	**Vaccine Vector 2**
Research director	Patrick	André	André
Participating scientists	Frédéric	Daniel Yannick (part time)	Christophe

Table 4: The LAB main research projects

Scientists devoted to each research project accomplish the bibliographical work needed to document their topic. This takes them approximately 10 to 20% of their time, mostly during pauses in experiments. Scientists also realize scientific manipulations needed to advance their project. Their experimental work entails the design of the experience (aim, methods, timing, required materials) and its actual implementation and follow-ups. Qualified technicians accompany scientists at every stage of experiments: they help them design and realize the manipulations.

It is worth noting that the three research projects are close regarding their subjects and methods. Moreover, all researchers share the same general scientific and experimental knowledge. They benefited from the same initial training in the same sub-field of biology (molecular biology) and got specialized at the doctoral and post-doctoral levels. Therefore, they all have already used the materials that everyone utilizes and they are more or less familiar with each other's research

topics. This point is significant for it makes possible for all scientists to interact concerning their respective scientific projects and experiments.

Moreover, the technicians, whether qualified or not, are not devoted to any research project in particular but they deal with distinct activities. Two of them, Annie and Renée, take care of the laundry service and of the sterilization of equipments. The qualified technicians have missions to help scientists to advance their project. Veronique is working as Claire's assistant and she is specialized in using the sequencer. Aurélie, who is Philippe's assistant, works mainly with the spectrophotometer. Sequencer and spectrophotometer are used, to a certain extent, in the three research projects. Finally, the two greatest lengths of service and the most qualified technicians, Philippe and Claire, are not really specialized in the use of any specific machine. They know how to utilize all of them and have a long experience of scientific manipulations.

Finally, because of the small size of the laboratory, no clear hierarchical and formal structure has been established. The center's features are close to Mintzberg [1979, p.483]'s adhocracy. Every scientist might ask anyone else (either scientist or technician) to help him achieve his/her experiment. To unravel the structure of the laboratory, we built the relationships between agents in terms of who is depending on whom in terms of access to complementary knowledge (figure 1). Since the laboratory can be seen as a knowledge intensive organization, this dependency network matches the overall structural functioning of the LAB. The arrows are oriented from the agent that asks for help to the agents that answers. The thicker is the arrow, the more frequent are the interactions between the pair of agents. In addition, not only individual agents are represented but also institutions with which agents are in contact.

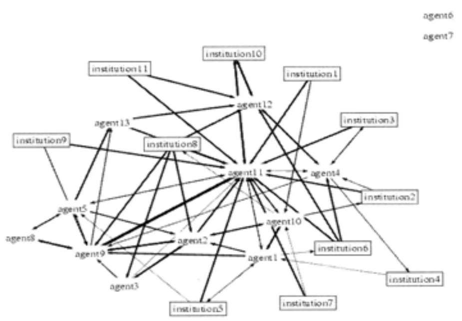

Figure 1: Graph of the structure of total communications

At first sight, the graph shows complex interdependencies between members and there seems to be no clear pattern. To refine our understanding of what occurs

in this social structure, one needs to split the graph of the figure 1 in finer categories. More precisely, it appears that two distinct modes of relations can be identified within the lab. On the one hand, particular relationships emerge around the issues related to manipulations, tools, experimental settings, etc. The knowledge mobilized during these interactions is know-how [Lundvall and Johnson, 1994] centered on the practical dimension involved in research in molecular biology. On the other hand, relationships are created between agents about the scientific dimension itself. By scientific dimension, we mean that part of the research activity that takes the shape of formal knowledge, articles, literature, etc. These two networks of relationships involve the same actors, but they occupy different specific positions and play different roles depending on which mode one considers. According to the definitions established above, we argue that the first mode of relation equates to a community of practice, whereas the second one defines an epistemic community. The following section explores the key differences between these two networks and attempts to draw more thoroughly the distinctions between the two types of communities.

Two observed Network Structures: an Epistemic Community and a Community of Practice

Hypothesis and choice of indicators

We base our analysis of the different structures on four indicators common in social network analysis: indegree, outdegree, closeness and betweenness. Moreover, to reflect the fact that the interactions are of various intensities, they are weighted with weights ranking from 0 to 5. Given a graph G = (I,D) with I the set of vertices and D = {d(i,j)} an adjacency matrix, then the indicators can be defined as follow:

Indegree of an agent in a directed graph is the number of edges that have this agent as arrival point. Formally,

$$N^{+}(v) = \#\{i \in I : d(i,v) \neq 0\}$$

Outdegree of an agent in a directed graph accounts for the number of edges that have this agent as starting point. Formally,

$$N^{-}(v) = \#\{i \in I : d(v,i) \neq 0\}$$

Degrees can be interpreted in terms of the sizes of actors' neighborhoods within the larger structure. In addition, links are weighted and d(i,j) can be greater than one. Since the studied networks display the interdependencies of agents in terms of knowledge, the degrees are indicative of the role of each agent. An agent having a high outdegree would be an agent that requests a lot of help from the other members of the organization. On the contrary, an agent having a high

indegree acts as an expert diffusing his/her knowledge towards the other members of the laboratory.

Closeness of an agent can be understood as a measure of the extent to which a given vertex has short paths to all other vertices in the graph; this is one reasonable measure of the extent to which a vertex is in the ``middle" of a given structure. [Wasserman and Faust, 1994]. Closeness of a vertex is defined formally as,

$$C(v) = \frac{|I| - 1}{\sum_{i \in I, i \neq v} g(v,i)}$$

where g(v,i) is the geodesic distance (shortest paths) between v and i (where defined).

Closeness is a measure attached to each node of the graph. An agent having a high closeness is central in the graph in that many paths go through him/her. S/he is then a central actor and a coordinator of the interactions taking place in the social structure.

Betweenness of an agent is a measure of the number of shortest paths between any pairs of agents to which this agent belongs. Hence, high-betweenness vertices lie on a large number of non-redundant shortest paths between other vertices. They can thus be thought of as playing the role of ``bridges" or ``boundary spanners'' within the network [Wasserman and Faust, 1994]. Betweenness differs from closeness in that there is no notion of centrality: an agent may have a high betweenness and a low closeness by being placed in the path between two cliques. We use betweenness precisely to identify these agents that are gateways between two tightly connected subgraphs. In our case, the network presents two types of vertices: individual agents and organizations. We make the assumption that organizations are made of several individual agents. Betweenness is here defined as,

$$B(v) = \sum_{i,j} \frac{\beta n_{iv} \times \beta n_{vj}}{n_{ij}} \quad with\ i \neq j \neq v$$

Where n_{ij} is the number of geodesics between i and j and β is a parameter reflecting the fact that an organization contains several individual agents. As a blunt estimation, we took β equals to the number of individual agents present in the lab under study (i.e. β = 13 if i is an organization, β = 1 if i is an individual agent).

These indicators are here intended to characterize each individual presents in the network. Our objective is to accounts for the different communication structure by analyzing the various roles played by actors in each social setting. To do so, we ran a cluster analysis over these four indicators in order to identify the various populations of roles played by agents in each network. In what follows,

we present the two graphs and the roles played by agents in each of these social settings.

Results

The two graphs below represents the structures of communication we explore in this subsection.

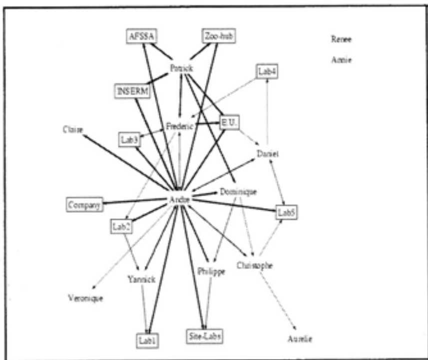

Figure 2- Graph of the structure of communications about science

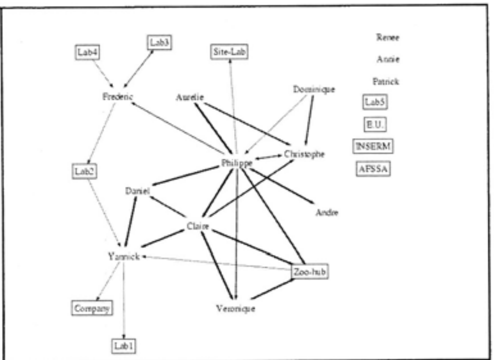

Figure 3- Graph of the structure of communications about manipulations

Network of communications with scientific content

	Indegree	Outdegree	Closeness	Betweenness	Cluster's composition
Cluster 1	5.50 (2.12)	8.00 (5.65)	0.26 (0.004)	0.19 (0.02)	Daniel, Frederic
Cluster 2	6.00 (2.94)	4.50 (1.29)	0.24 (0.02)	0.02 (0.04)	Christophe, Philippe Yannick, Dominique
Cluster 3	9.00	29.00	0.25	0.03	Patrick
Cluster 4	1.40 (2.07)	0.00 (0)	0.04 (0)	0.00 (0)	Claire, Veronique Aurelie, Renee Annie
Cluster 5	17.00	73.00	0.31	0.45	Andre

Table 5- Average values related to the different types of agents present in the graph of scientific communications (means (standard deviation))

The clusters only include individual agents. However, measures were computed taking into account organizations. We find a divisive coefficient of

0.83, which indicates a good discriminatory power of the chosen variables. Cluster 4 appears as irrelevant for scientific communications network and contains agents not participating directly in scientific knowledge production. The agent captured in cluster 5 clearly stands out of the population of agents. Indeed, he is the one having the highest degrees, the highest closeness and the highest betweenness. This agent appears as the leader of the community in the sense of Knorr-Cetina [1999]. According to her, leaders in scientific labs are at the center of communications network and participate actively in every scientific work taking place in the lab (which is here the case, as indicated by the closeness and the degrees of the agent). Moreover, these agents also play the role of spokespersons for the lab toward the outside. This is the case here, as shows the high betweenness of the agent. In our theoretical framework, this agent is the one endowed with procedural authority, coordinating the work and indicating what way to pursue in research.

Cluster 1 and cluster 2 contains agent participating actively in scientific knowledge production within the lab, as demonstrate the values of degrees and closeness. However, they play little role in the circulation of knowledge, as their low betweenness indicates. These agents are thus encapsulated in the local social structure, participate actively in lab's projects, but do not play the role of spokespersons for the lab. The higher level of the betweenness of cluster 1 compare to cluster 2 may indicate that the former is constituted of more confirmed scientists that gained enough acknowledgement by their peers to start to communicate toward the outside and to be in charge of one of the projects of the lab. These results are in agreement with the work of Girvan and Newman [2001] exploring the structure of scientific collaborations.

By construction, this network contains scientific knowledge, explicit by nature. Moreover, the analysis highlights the existence of an agent endowed with a procedural authority. This procedural authority is the glue holding the members in collective thrive (as revealed by the interviews). Lastly, the leader also acts as a spokesperson and communicates the results of the lab toward the outer world. This social structure thus fully qualifies as an epistemic community as we defined it above.

Network of communications about manipulations

	Indegree	Outdegree	Closeness	Betweenness	Cluster's composition
Cluster 1	7.33 (5.42)	5.83 (3.06)	0.09 (0.004)	0.00 (0.001)	Daniel Christophe Veronique Aurelie Andre Dominique
Cluster 2	4.00	2.00	0.09	0.22	Frederic
Cluster 3	15.50 (2.12)	29.50 (3.53)	0.10 (0)	0.16 (0.02)	Claire Philippe
Cluster 4	11.00	10.00	0.09	0.30	Yannick

Table 6: Average values related to the different types of agents present in the graph of communications related to manipulations (means (standard deviation))

We find a divisive coefficient of 0.84, which indicates a good discriminatory power of the chosen variables. The number of degrees indicates that the level of communication is high, as was the case in scientific communications network. In particular, cluster 2 display high values for indegree and outdegree, suggesting that agents contained in this network are solicited often regarding experiments. However, compared to scientific communications network, the values of closeness are much lower, indicating that in this case, no agent play a really central role in the overall network coordination. This suggests that although some agents are able to communicate a lot about practice of experiments, they do not play a role of leader in the network of communications about manipulations. Also, betweenness is more spread among agents, pointing that circulation of ideas depends on more individuals than in the previous case. The conjunction of these two facts evidence that communication toward the outer world is not carried out by one single individual, but rather by several ones not standing at the core of the network.

The communications in this network deal with know-how involved in the conduct of experiments. The structure of the network with highly skilled actors at its center and less experienced ones at its periphery is typical of a community of practice. Lave and Wenger [1991] insist on the fact that in a community of practice, agents move from the periphery to the core of the community as they become increasingly skillful. Besides, it is worth noting that the connections with other organizations are made by these peripheral agents (another important point stressed by Lave and Wenger [1991]. One is thus facing a community of practice.

Articulations between the two observed structures

The LAB then exhibits two internal groups that can be labeled epistemic community and community of practice. The organizing (in a weickian sense [Weick, 1969]) of the LAB constantly intertwines these two communities. One might advance that LAB's performance in terms of success of experiences, patents and publications depends on the relationships between these two communities. In this sub-section, we propound that these links are established through objects and people.

Objects

Specific objects, in particular lab books, make the two communities interconnect. Lab books correspond to the written traces that agents keep of their experiments. Technicians are the ones who write the minutiae of experiments. They detail preparation procedures, used materials, followed steps, as well as the results of the experiments (such as failure for lack of accurate observations, extreme results, expected changes). They advance in the explanation of these results.

> Claire: "Ah, the lab book: [I am noting things] all the time. I literally fill it every day. Every time I am taking part in an experiment I fill it. I write everything. I write as much as I can every time I am on the work surface. For instance, regarding sequencing, I got to the volume 12 or 13, to my remembrance. (...) "

These lab books keep the memory of experiments. Technicians fill it with the details of experiments while scientists refer to them when something is not going well and / or to advance on a project.

> André: "The aim of the lab book is to keep trace of the making of a technique, to make it evolve, to note what is working and what is not working. It also helps to understand why some things used to work and do not any more."

The lab book plays the role of a boundary object between scientists and technicians. Boundary objects are flexible, abstract, polyvalent and standardized enough so that different social worlds can use them and communicate through their usages [Star and Griesemer, 1989]. In the LAB case, the lab book transits from technicians to scientists. In this paper, we go further by advancing that lab books serve as links between the community of practice and the epistemic community. The lab book represents a written memory of the actual practice of scientific experiments. In this regard, it is a central part of the joint 'repositories' that characterize the organization of communities of practice, according to [Wenger, 1998]. At the same time, the lab book constitutes a key step to the advancement of scientific programs. Scientists refer the details of experiments to elaborate their proofs and test effects. Uses of the lab book constitute a central intermediate step to the achievement of the central activity of members of epistemic community: the construction of knowledge. Members who are core to

the community of practice constitute the lab book, which in turn contributes to the re-foundation of the epistemic community.

An intriguing aspect is that the ones who are in charge of the constitution of the lab book constitute it with their identity of member of a community of practice. We saw previously that making knowledge more explicit is much more a defining feature of epistemic communities than of communities of practice. The writing of the lab book by members of the community of practice then contributes to the interrelation with the epistemic community by transforming the knowing of communities of practice into knowledge to be referred to by the epistemic community.

People

People also relate the two communities first because they play with their simultaneous memberships to them. This relation between community of practice and epistemic community through specific persons is exemplified by Frédéric, the new doctoral student. Frédéric's practices exhibit his two simultaneous but distinct memberships to the community of practice and to the epistemic community. Frédéric plays with his identities in the laboratory and relates to them differently according to the realm of work that is involved. When realizing his own lab book, Frédéric emphasizes the details of experiences. Afterwards, Frédéric goes back to his lab book to advance on his research project. He does not relate to the same persons to help him constitute or analyze his lab book. When he writes it, he refers to Philippe, the technician at the core of the community of practice. When he examines it, he asks Patrick, his scientific referent, for advice.

Second, at a more collective level, key individuals ensure that the two communities interconnect and contribute to the accomplishment of the overall objective of the entity. The long-lasting relationship between Philippe, who appears as the main referent in the community of practice, and André, head of the center and chief scientist of the LAB plays such a role.

The relationship between these two boundary spanners makes the two communities interconnect. This example nevertheless markedly differs from more customary examples of boundary spanners [Ancona and Caldwell, 1992; Burt, 2000]. Interface persons, usually, are individuals who belong to two social worlds simultaneously and make them communicate through their unique double memberships. Moreover, they lie at the periphery of these two social worlds in order to be acquainted at a minimum to the two cultures. In the LAB case study, on the other hand, Philippe and André occupy central positions in the two communities. Philippe is at the heart of the community of practice, showing his experience and giving advice to technicians and scientists. Philippe is also integrated to the epistemic community thanks to his acquaintance with André. André is not peripheral to the community of practice either. Members of the COP constantly refer to him. They direct many of their messages to him (cf. network).

At the same time, André is the most central individual in the epistemic community. His relationships in this community are more bilateral. Both André and Philippe then appear as core individuals in the two communities.

In a more dynamic perspective, Philippe's situation and competences evolved as well as his relationship with André. Eighteen years ago, he was exclusively a technician. However, three years ago he resumed his formal training and passed a master degree that allow him to enter a doctoral program, if he wanted to.

This master degree makes Philippe gain the same kind of knowledge as LAB's scientists. His individual trajectory makes him gradually become a key member of the epistemic community (by respecting its formal rules of entry, getting to know its explicit knowledge and taking part in specific scientific projects) while remaining a central member of the community of practice.

Conclusion

This study grounds empirically the distinction between two types of community, communities of practice and epistemic community. Communities of practice are engaged in the daily activities of the organization and oriented toward the perpetual enhancement of individuals' skills in achieving these activities (the conduct of experiment in our case). In this case, knowledge creation is a means to gain efficiency in the practice. Epistemic communities, by contrast, focus explicitly on the creation of new knowledge. This generation of new peaces of knowledge is an end for epistemic communities. This difference in the objectives yields differences in the social norms adopted and in the social structure emerging in each community.

These two social structures are connected one to the other through two important means: boundary objects and boundary spanners. These specific objects and individuals allow a smooth articulation of the two types of communities and hence of the different types of knowledge necessary to the achievement of the organization's objectives. In this respect, boundary objects and boundary spanners realize the necessary combination of the different learning processes taking place within the laboratory. From a managerial standpoint, this implies that one must seek a balance and harmonious relationships between the different communities populating the organization in order to reach a good organizational efficiency.

However, this work present several limitations. First of all, our empirical study only deals with one case. It thus makes it difficult to draw robust implications regarding communities management. There is clearly a need for further empirical research on a broader scale. Moreover, our analysis remains essentially static. We did not explore the path of evolution of the various communities, their possible segmentation, mixing, re-organizing, etc., while these questions are of up most interest for instance in the study of free software development. All these limits are

indicative of the work that remains to be done in the exploration of communities and their impacts on the functioning of organizations.

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We Can See You: A Study of Communities' Invisible People through ReachOut

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Abstract. Virtual communities are a great tool, both at home and in the workplace. They help in finding new friends and solving complicated problems by creating a virtual family or a giant group-mind. However, building a virtual community is not a trivial task. Many problems need to be addressed for a new community to be successful. While many of these problems are features of the medium, participants themselves are still the major part of the equation. Understanding the behavioral patterns of virtual community members is crucial for attracting participants and facilitating active participation. In this paper, we describe our findings from analyzing more than a year of activities of a workplace community. Our community used ReachOut, a tool developed in our group to support semi-persistent collaboration and community building. Throughout the year, all users' activities were logged, providing us with very detailed information. Not only do we know of people's postings to the community, but we can also track lurking behavior that is usually hidden. This allows us to check several hypotheses about non-active participants' behavior and propose some directions to increase active participation in virtual communities.

Introduction

From the early years of the Internet, virtual communities became one of the most widespread and important applications of the new technology (Rheingold 2000).

M. Huysman et al. (eds.), Communities and Technologies, 65-79.

In this era, when our sociability and community involvement are steadily decreasing (Putnam 2000) it is important to understand how this new medium can help us start collaborating again.

There are many efforts and applications aimed at building strong communities, both for leisure activities (The Well; Rheingold 2000) and in the workplace (Erickson et al. 1999; Hagel and Armstrong 1997). However, this task is far from being trivial or simple. Communities are built with great effort, and die easily (Stone 1994). Critical mass of participants (Markus et al. 1990), reciprocity (Harrison and Dourish 1996), and interactivity (Rafaeli 1988, Rafaeli and Sudweeks 1997) are just some of the factors that influence the "stickiness" of a community. In part, these are features of the medium itself, but some still depend on the people participating in the process. It is therefore crucial to understand people's behavior in computer mediated space.

Most of the current research is dedicated to studying **public** activities of virtual community participants (Whittaker et al. 1998; Rafaeli et al. 1998; Preece 1998). The reason for this is that in most of the community supporting tools – Usenet newsgroups, forums, BBSs – non-public behavior is very hard or even impossible to trace. One can easily define non-active participants (a.k.a. lurkers) in mail distribution lists (Nonnecke and Preece 2000) as those who are registered to receive postings but never post themselves, but this approach supplies limited understanding of lurkers behavior, and personal interviews are required to shed some light on the hidden patterns of this behavior (Nonnecke and Preece 1999).

ReachOut is a semi-persistent collaboration and community building tool that was created in the IBM Haifa Research Lab at the end of 2001 (Ribak et al. 2002). As in Usenet newsgroups, ReachOut allows people to post questions to peers, but provides a semi-persistent chat-based interface, creating a more informal environment to foster collaboration. In addition to traces of active participation in discussions, the ReachOut server also records the activities of those who visit discussions without posting to them (lurkers). This feature gives us a unique opportunity to gather more detailed statistics on non-active participants' behavior and analyze it, verifying hypotheses that were raised in the literature about non-active behavior in virtual communities.

The rest of the paper is organized as follows: We begin by reviewing the related work, identifying previous hypotheses about invisible virtual community participants, and singling out the hypotheses we wish to verify in this study. In the next section, we briefly describe the ReachOut tool and its logging techniques. We go on to describe the methodology of our study and present the results of our analysis. We conclude by proposing some future work directions in studying participation in virtual communities, and some improvements to existing tools.

Related Work

While it is very difficult to study phenomena that cannot be observed, a body of related work on non-active participation does exist. Putnam, in his book 'Bowling Alone' (2000), notes that the level of participation in community activities in America is declining with the years. An interesting discussion on The Well (Are you a lurker 1992) indicates that people tend to map their real life behavioral patterns to computer mediated communication (CMC) and thus it is expected that the increased number of inactive people in real life will result in an increased number of lurkers in online communities.

The free rider problem is defined as a situation when people use the common good without contributing to it (Sweeney, 1973). Kollock and Smith (1996) point out that non-active participation in online forums may be viewed as free-riding. There have been studies about patterns of behavior of users in discretionary databases (Thorn and Connoly 1987) that can eliminate or reduce free-riding. It should be noted, though, that people who do not have new information to contribute, actually assist the community by reserving their already stated thoughts to themselves, rather than cluttering the space with repeated ideas.

Rafaeli and Sudweeks (1997) recognize lurkers as an important part of Internet groups, but admit that there is no information on their activity. Whittaker et al. (1998) also acknowledge the fact that while lurking is a prevalent activity, it leaves no public traces, so it cannot be fully studied. One type of electronic medium, in which lurking behavior actually may be observed, is mail distribution lists (DLs). Nonnecke and Preece (1999, 2000) use DLs for their study, by defining lurkers as people who are subscribed to the list but never post anything, or post very few messages. Our peer support and community building tool, called ReachOut (Ribak et al. 2002), has a unique logging system that provides exact information on behavioral patterns of participants in a newsgroup-like medium, so it would be interesting to verify existing findings and hypotheses about lurking behavior based on the data we collected

Examining the behavior of visitors to web sites that host public forums can also give us an indication of lurking behavior. Katz, in his column "Luring the Lurkers" in SlashDot (1998) cites a survey from a computer consulting firm in Chicago, that studied behavioral patterns of large sites visitors. Similarly, Mason studied a football fans site (1999).

One of the most obvious observations about lurkers is their numbers. The survey cited by Katz found that 98% of large sites' visitors are lurkers. Mason reported a lurking level of 90%. While these numbers are impressive, they are quite easily explained, as no active participation is expected of a visitor to a Web site, even if the site has a forum. More relevant numbers are those reported by Nonnecke and Preece (2000), where they report their findings in a study of DLs,

and find that lurking levels vary from 45% in health support distribution lists to 82% in software related DLs, with an average of 55%.

We assume that several factors affect the level of lurking in a medium. Media which utilize a "push" paradigm (such as DLs and ReachOut) are expected to exhibit higher lurking levels than those with a "pull" paradigm, since users do not invest any effort to view postings after their initial subscription. On the other hand, DL users are required to explicitly unsubscribe from the list in order to terminate lurking, while ReachOut users can drop out altogether simply by refraining from logging in to the system. Thus we would predict that ReachOut lurking levels would be lower than lurking levels in DLs. We also anticipate that people will tend to lurk more in highly public places, such as internet forums, where the atmosphere is not always friendly and polite, and a comment on the forum is liable to result in a flame...

The first question we wish to pose is:

Q1: How do lurker levels in ReachOut compare with prior findings?

Another prevalent assumption about lurking is that it is an important form of learning about the community. Kraut et al. (1992) point out that background behavior is an important way for novices to learn about a new topic. Whittaker et al. (1998) define it as peripheral participation, until a topic of direct interest is spotted. Donath (1996) proposes that people often try to find out about other participants from their postings' content. Finally Nonnecke and Preece (1999) clearly define learning about the community culture as one of lurkers' activities – 70% of the users interviewed stated they lurked to get to know the group better.

While it is difficult to learn about educational lurking without actually interviewing the users, it is possible to find out the amount of time that passed before people attempt their first posting. This would give us an indication of the time it usually takes people to get comfortable with the community and start active participation. In addition, we can also check whether the educational lurking time in any way affects the consequent posting behavior of the user. Thus our next questions are:

Q2a: How long do people lurk before they post for the first time?
Q2b: What is the correlation between this time and future posting behavior?

According to Rafaeli (Rafaeli, 1988), interactivity is a very important part of any virtual community. Moreover, it affects performance quality, motivation, sense of fun, cognition, learning, openness, frankness, and sociability. It would be interesting to see how interactive discussions affect people who interact in them for the first time. Our next question is thus:

Q3: Is there any correlation between the user's first posting experience, and the decision to become an active participant?

Finally, Nonnecke (2000) pointed out non-fluent English as a reason for lurking. The community we studied with ReachOut had participants all over the globe. We may therefore evaluate this hypothesis:

Q4: Is there a noticeable difference between lurking behaviors of native English speakers vs. non-native speakers?

In the next section, we present ReachOut, the tool we used to collect our data, and a community which used ReachOut for a period of slightly more than a year.

ReachOut and the ROPE Community

The ReachOut Tool

ReachOut is a tool for peer support and community building, created in IBM Haifa Labs. While the implementation details and the theoretical background of this tool are described elsewhere (Ribak et al. 2002), we provide a short description of the ReachOut components that are relevant to this paper.

ReachOut's main goal is to provide peer support. Just like Usenet Newsgroups, it provides an environment for posting questions to predefined interest groups, but uses a push technology to notify people of new or updated questions.

Figure 1: ReachOut in the system tray.

In its minimized mode, ReachOut appears as a system tray icon, which is overlaid by an exclamation point when a notification arrives (Figure 1). When users decide to open the application, they see a narrow bar where all new and updated discussions' titles fade in and out, decorated with icons that indicate their status (Figure 2). Users may then navigate through discussions in several ways, based on groups of interest, discussion title, name of asker, or status of discussion.

Figure 2: The ReachOut bar.

A ReachOut discussion is very similar to a conference chat, though it is persistent through time; thus new participants can see the full discussion transcript. Users can also see the history of participation; the discussion transcript contains past entries, and the participant list doesn't only show active participants but also people who contributed to the discussion in the past and are not currently there (Figure 3). People who enter the discussion but do not contribute to it (lurkers) are shown in the participants list only as long as they are online. The ReachOut server logs every entry to any discussion in its log file. This provides us with a set of data to be parsed and processed, in order to study users' behavior.

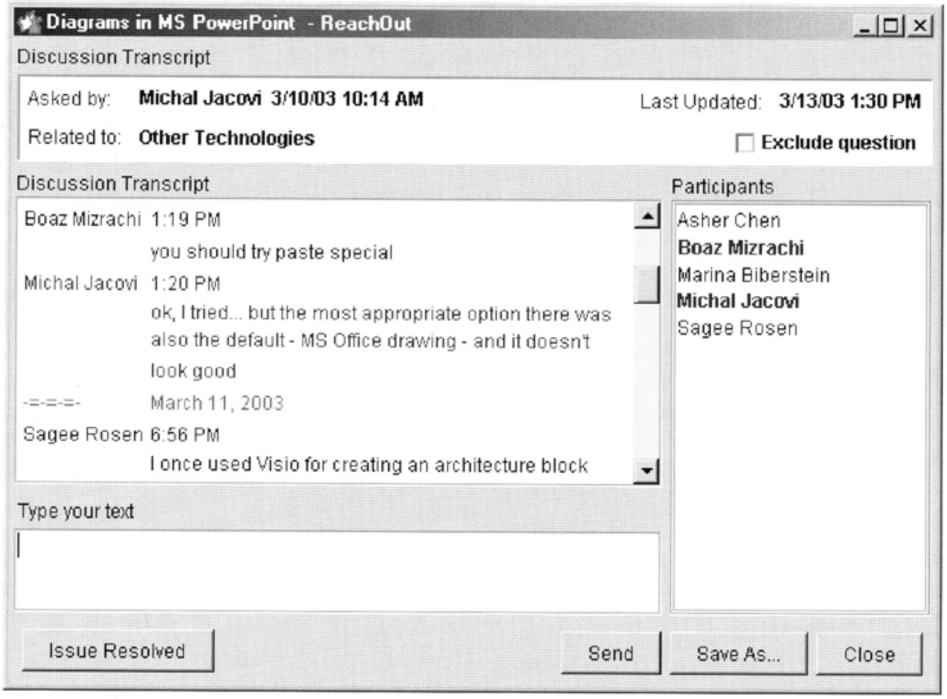

Figure 3: Discussion window.

The ROPE Community

ReachOut was deployed in a community of IBM General Technical Sales Support division. The community is called ROPE (ReachOut for Practitioners Expertise), it was launched on December 2001, and has been monitored by us ever since. The log file we use for the analysis of this paper was frozen at the beginning of

January 2003, and thus covers 13 months of activity. The ROPE community consists of people with high technical skills who provide support for the IBM sales force. During the study, 822 users from 31 countries used ReachOut at least once, and 370 discussions were conducted. For our research purposes, we removed from the studied population the users we defined as "the core team" – the developers and the champion customers, whose behavior on the tool may have been influenced by their direct connection to the project and this research. This group included 16 users. We also removed all those people who tested ReachOut only once but did not come back to it – there were 300 such users. After this cleanup, we were left with 506 repeating users. These served as the population we studied. We argue that over 500 repeating users is a valid population to verify our hypotheses.

Methodology

ReachOut logs each and every action performed by users. There are nine types of actions, from which only six are relevant to the present study:

- User logged in
- User logged out
- User entered discussion
- User left discussion
- New discussion created by user
- New posting is appended to discussion

All logged data was processed and accumulated using a custom Java based log analyzer and standard statistics tools.

In the next subsections, we define our main variables.

Lurkers

A simple definition of lurkers, one that matches the definition in the related work section, would be those people who never posted to discussions in the system. However, as the logged events on ReachOut are much richer, we can actually tell when users enter a discussion, and thus we can offer a more precise definition of lurkers. We see lurkers as those who not only did not post anything, but also actually read other people's discussions – these are the real lurkers.

In order to explore yet another definition, we followed the approach taken by Nonnecke and tried to explore the level of lurking when the definition of lurkers is relaxed to those who posted a minimal number of postings. The average number of postings of the entire population through the period of our experiment, is 30, we may thus choose to relax our definition to those who posted three times or less.

Educational Lurking

We define educational lurking as the period of time from the first login of the user until the first posting. There are three measures for this behavior – the absolute calendar time from the first login to the first posting, the actual online time in the same period, and the number of times the user visited other discussions before posting for the first time. We will show results for all three measures.

When studying educational lurking, we focus on the people who participated at least once, as the educational lurking period for the real lurker is indefinite – they never posted "for the first time". We examined two different groups of participants – those who became active participants (120 users), and those who qualified as lurkers under our relaxed definition above – namely they posted up to three postings (115 users).

Interactivity

Rafaeli and Sudweeks (Rafaeli and Sudweeks, 1997) discuss a continuum of interactivity, with declarative (one-way) communication on the one end, followed by reactive (two-way) communication, and full-interactivity at the other end (with messages that directly refer to how previous messages in the same discussion related to others). We chose to focus our measurements on the definition of reactive communication, and define "users' first interactivity experience" as the number of messages that directly referred to their **first** posted message. It is likely to assume that the first experience of users would influence the rest of their interaction with the community. A user that receives a good reaction to a first posting is likely to become a contributor to the community. A user that receives a bad reaction may retreat and refrain from participating. Not getting any reaction at all may be perceived as a bad reaction, though we may assume that user would make a few more attempts to participate. As the community of our study is a workplace community, we do not expect to encounter too many bad reactions that would drive users away. We shall therefore aim at studying the difference between users who were welcome, and those who were ignored. We assign a score to users' first interactive experience, as the number of messages that directly referred to the first posted message, and study the correlation of this number with the users' level of future participation.

We chose a random sample of 15 active participants and a random sample of 15 lurkers under the relaxed definition (a bit over 10% of both populations). We then located the first discussion of each of these users and counted the number of messages that were referred directly to their first message. We then compared these two samples to see if there is any correlation between interactivity of the first discussion and consequent participation behavior.

Non-native English Speakers

Since ReachOut has been deployed inside IBM, an American company, we could assume that most of our users are fluent English speakers. However, many of the users come from different countries and therefore are non-native English speakers. The influence of this fact on their lurking behavior is an interesting subject for a study. Not having accurate information on the English level of our users, we based our study on the country in which our users are located. We defined users from the US, UK, Canada, and Australia as native English speakers, and those from the rest of the world, as non-native English speakers. In IBM, the e-mail addresses contain the country code suffix, and so we used this information in order to classify our users.

Results

Number of Lurkers

Our log file indicates that 263 of the repeating users match the first definition. This counts for 52% of the population.

It turns out that out of the 263 users who never participated; only 232 entered other people's discussions. These are 45.8% of the population. An interesting fact is that 31 of the non-participants, never even looked in other discussions. Those users are equivalent to DLs subscribers who for various reasons do not unsubscribe from the list, and yet they never bother reading the postings. This kind of behavior cannot be studied in DLs, and only ReachOut's unique logging mechanism reveals it. While such subscribers to DLs are passive users who may simply ignore the notes that are distributed to them, on ReachOut they actively log in. According to our data, they were on ReachOut an average of 491 minutes (with an exceptional case of a user who was online for 2580 minutes). They logged in over three times on average, and yet they never ever bothered looking into any discussion. Why they kept coming back and what benefit they got out of ReachOut is a puzzle.

The relaxed definition of lurkers yields 387 users, which are 76.5% of our population.

Educational Lurking Levels

The results we discovered for the educational lurking measures imply that there is no statistically significant difference between active participants and lurkers under the relaxed definition, in any educational lurking parameters. The data represent a highly right skewed distribution with mean of around 10 days of absolute calendar

time, around 5 hours of online time and around 6 lurked discussions prior to the first posting and very high p values (p=0.8). Similar results were obtained for both populations, indicating that none of the parameters that we examined influence the users' future participation behavior.

Interactivity

To analyze the effect of the interactivity of the first experience we selected two random samples of 15 users each – one from the collection of active users and the other from the collection of lurkers under our relaxed definitions (p=0.029 indicated that this relatively small sample was sufficient). For each user in the sample we manually analyzed the first participation and counted the number of messages that directly referred to it. This definition of interactivity is rather objective and well defined, and indeed, there was a very good correlation between results that were counted by two different judges. The results of the analysis are brought in Table 1, where users who later turned out to be active users are marked "heavy", and those who kept a low profile are marked "light".

Participation Levels	**Mean**	Std. Deviation
Light	1.3333	**1.54303**
Heavy	**3.5333**	**3.37780**

(t=-2.294, p=0.029)

Table 1: Interactivity score results

The mean score of first interactivity experience for heavy participants is 3.5, while the same value for light participants is 1.3 ($p<0.05$). These results clearly show that there is a significant correlation between the users' first interactivity experience and their level of future participation in the community.

Non-native English Speakers

Table 2 summarizes the results of native English speakers against lurking behavior, when lurking is defined as no posting at all. The table clearly shows that there were many more lurkers (71.7%) among non-native English speakers than among native English speakers (47.9%). Moreover, among English speakers, there were more participants than lurkers.

English Level	Lurker	Active
Native	185 / 47.9%	**201 / 52.1%**
Non native	**86 / 71.7%**	**34 / 28.3%**

(V = 0.202, P=.000).

Table 2: Native English for regular lurker definition results

When relaxing the definition of lurking to up to three postings, the resulting table is less striking (Table 3).

In this case, the vast majority of non-native English speakers are lurkers (85%) against 73% of English speakers. Under this relaxed definition, the phenomenon of "more posters than lurkers" disappears. A clear correlation is still apparent between the levels of lurking and English as a native language.

English Level	Lurker	Active
Native	285 / 73.8%	**101 / 26.2%**
Non native	**102 / 85%**	**18 / 15%**

(V = 0.112, P=.012).

Table 3: Native English for relaxed lurker definition results

Discussion

Our results are consistent with previous findings with slight changes, derived from the additional information ReachOut logging mechanism can provide. The average lurking level is 52%, compared to the overall of 55% in Nonnecke and Preece's study (Nonnecke and Preece, 2000).

We also identified a completely new population. This population may be defined as users who are absolutely passive, who log on to the community, but do not take any part in the community life, neither by posting nor by reading. While in other mediums these users were not distinguished from other lurkers, here they are not the audience – these users are not important for the community to function, since they do not even free-ride – they do not ride at all. As we stated before, it would be interesting to study those users, who, while not participating or reading, spent a relatively long time in the tool.

By eliminating the passive users' data, we achieve a lurking level of 45.8%, which strikingly resembles the 45.5% result reported by Nonnecke and Preece (2000) in healthcare-related DLs. This phenomenon may be easily explained by the similarity between the environments. The atmosphere in the healthcare lists is generally pleasant and supportive, just like the atmosphere in the workplace-based

ROPE community, and contrary to the rough-and-tumble of public forums. Furthermore, DLs use a "push" paradigm, just as ReachOut does, in contrast to forums, which employ a "pull" paradigm.

While it was impossible to fully explore the educational lurking patterns, it was very interesting to find out that there is no statistically significant difference between heavy and light participants in educational lurking levels. It can point to the fact that people tend to learn about the community and then decide whether or not they want to participate. As Katz pointed out (Katz, 2000) the educational lurking can lead to the decision not to post (for example, because of the bad atmosphere in the group). However, if users decide to post, their first experience of interactivity may strongly affect their decision to persist in posting.

Our next finding supports this assumption. The first experience of active posters was on average much more successful. In fact, there were several people in our sample that received up to 12 posts that directly referenced their first discussion posting; this phenomenon was not observed for the light posters. It clearly comes in agreement with the fact that the postulated outcome of interactivity is engagement (Rafaeli and Sudweeks, 1997). When it is very important to foster active participation (in work related forums for example), forum moderators should monitor discussions and make sure that the first experience of people using the system is as interactive and pleasant as possible. This includes posting welcome messages and in the case of topic-based forums, even trying to locate relevant people to help the first time poster solve a problem or discuss an issue.

In this study, we were also able to check the postulate that non-native English speakers have a higher chance of lurking. While our methodology has its limitations (since the correlation between native language and country of residence is not absolute), it is a close approximation to the level of English skills. Our results show that there is a clear correlation between English skills and participation in CMC. This means that local computer mediated forums should aim to use the native language of the country rather than English. Various tools for automatic translation could also benefit the online community, though this technology is still immature.

Conclusions and Future Work

Lurkers are a very important part of any online community. However, it is sometimes, especially when a community is just emerging, very important to make sure users persist in staying and also in contributing to a community. That is why it is very important to study not only the lurking behavior per se, but also the dynamics that lead people to post.

This study confirmed previous assumptions about lurkers' demographics in computer mediated forums, but also highlighted some interesting features of

community participants. For example, there are people who persist in staying but do not participate (even silently) in any community activity. It will be interesting to find out why they do that and how to encourage them to become more active. Interactivity of the first experience affects users' decisions to stick with the community, so it is very important to continue and study the phenomenon of interactivity and its catalysts. Of course a pleasant atmosphere in the community can contribute to its success. Finally, it is important to let people lurk as they like to learn about the community. Because the period of educational lurking does not affect users' participation, pushing users might not be a good idea.

Finally, the significant difference in participation levels based on native language may be masking other, cultural differences. Different cultures may exhibit diverse norms of participation in discussions, and some of the discussion material itself may be specific to the US, where the majority of users were based. Further research is needed to explore the effects of these factors on participation level.

There is a lot of information that can be extracted from ReachOut logs. Since there are now several new communities of ReachOut, we hope to continue studying the behavioral patterns of users in computer mediated environments. We will pursue questions such as public vs. private lurking (are lurkers visible or hidden to other participants), social networks established inside a community, and various aspects of information sharing.

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Email as Spectroscopy: Automated Discovery of Community Structure within Organizations

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Abstract. We describe a method for the automatic identification of communities of practice from email logs within an organization. We use a betweenness centrality algorithm that can rapidly find communities within a graph representing information flows. We apply this algorithm to an email corpus of nearly one million messages collected over a two-month span, and show that the method is effective at identifying true communities, both formal and informal, within these scale-free graphs. This approach also enables the identification of leadership roles within the communities. These studies are complemented by a qualitative evaluation of the results in the field.

Introduction

Email has become the predominant means of communication in the information society. It pervades business, social and technical exchanges and as such it is a highly relevant area for research on communities and social networks. Not surprisingly, email has been established as an indicator of collaboration and knowledge exchange [Wellman, 2002, Whittaker & Sidner, 1996]. Email is also a tantalizing medium for research because it provides plentiful data on personal communication in an electronic form. This volume of data enables the discovery of shared interests and relationships where none were previously known [Schwartz & Wood, 1992]. Given its ubiquity, it is a promising resource for tapping into the dynamics of information within organizations, and for extracting

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the hidden patterns of collaboration and leadership that are at the heart of communities of practice.

Communities of practice are the informal networks of collaboration that naturally grow and coalesce within organizations. Any institution that provides opportunities for communication among its members is eventually threaded by communities of people who have similar goals and a shared understanding of their activities [Ouchi, 1980]. These communities have been the subject of much research as a way to uncover the structure and communication patterns within an organization—the reality of how people find information and execute their tasks. (for example, see [Blau and Scott, 1962], [Burt, 1980], or for a survey see [Scott 1992]).

These informal networks coexist with the formal structure of the organization and serve many purposes, such as resolving the conflicting goals of the institution to which they belong, solving problems in more efficient ways [Huberman & Hogg, 1995], and furthering the interests of their members. Despite their lack of official recognition, informal networks can provide effective ways of learning, and with the proper incentives actually enhance the productivity of the formal organization [Crozier, 1964, Crane, 1972, Lave & Wenger, 1991].

Recently, there has been an increased amount of work on identifying online communities (a brief overview of this work can be found in [Wellman, 2001]). Some of this work finds that online relationships do indeed reflect actual social relationships, thus adding effectively to the "social capital" of a community [Wellman, 2002]. Mailing lists and personal web pages also serve as proxies for social relationships [Adamic & Adar, 2002], and the communities identified from these online proxies resemble the actual social communities of the represented individuals. Ducheneaut and Bellotti conducted in-depth field studies of email behavior, and found that membership in email communities is quite fluid and depends on organizational context [Ducheneaut & Bellotti, 2002].

Because of the demonstrated value of communities of practice, a fast, accurate method of identifying them is desirable. While the literature pertaining to the theory of communities of practice is extensive, there is less work devoted to the task of identification. Classical practice is to gather data from interviews, surveys, or other fieldwork and to construct links and communities by manual inspection (see [Allen, 1984], [Hinds & Kiesler, 1995] or an Internet-centric approach in [Garton, Haythornwaite & Wellman, 1999]). These methods are accurate but time-consuming and labor-intensive, prohibitively so in the context of a very large organization. Alani et al. [Alani et al., 2002] recently introduced a semi-automated utility that uses a simple algorithm to identify nearest neighbors to one individual within a university department. However, this program relies on previously collected relational data that may be difficult to obtain for a given organization.

This paper presents a fully automated method for identifying communities of practice within an organization. The method uses email data to construct a network of correspondences, and then discovers the communities by partitioning this network in a particular way, which we describe below. The only pieces of information used from each email are the names of the sender and receiver (i.e., the "to:" and "from:" fields), enabling the processing of a large number of emails while minimizing privacy concerns.

We describe an experiment performed within our own organization, HP Labs, using nearly one million email messages collected over a period of roughly two months. The method was able to identify small communities within this 400-person organization in a matter of hours, running on a standard Linux desktop PC. In addition, we utilized the network of correspondence to identify leadership within these communities. This experiment was followed by a qualitative evaluation of the experimental results in the "field", which consisted of sixteen face-to-face interviews with individuals in HP Labs. These interviews validate the results obtained by our automated process, and provide interesting perspectives on the communities identified.

Identifying Communities

The method we used to automatically identify communities within an organization consists of two basic steps. The first one uses the headers of email logs to construct a graph where the vertices are senders or recipients of email messages and the links denote a direct email between the nodes they connect. The second step uses the algorithm that we describe below to find the communities embedded in the graph.

It is straightforward to construct a graph based on email data, in which vertices represent people and edges are added between people who corresponded through email. The minimum number of messages passed between any two vertices defines the threshold that one can vary to construct the graph. We find that graphs created in this way are power-law for high threshold values, in the sense that there are a few vertices with a high number of links and many with few links. Given that our measured exponent is less than 3.5, we expect the graphs to consist of one giant connected component and many smaller isolated components of O(1) vertices [Aiello et al., 2000]. Since the smaller components can clearly be identified as communities; the task remains to identify communities within the giant component.

A graph can be said to have community structure if it consists of subsets of vertices, with many edges connecting vertices of the same subset, but few edges lying between subsets [Girvan & Newman, 2002]. Finding communities within a graph is an efficient way to identify groups of related vertices. We applied the non-local process of Wilkinson and Huberman [Wilkinson & Huberman, 2002]

which partitions a graph into discrete communities of nodes and is based on the idea of betweenness centrality, first proposed by Freeman [Freeman, 1979]. A key feature of this process is that, based on the structure of the graph, it is able to distinguish and suppress isolated inter-community correspondences, so that the correspondents involved are placed in different communities.

In order to explain the community discovery process we consider as a first example the small graph shown in Figure 1. This graph consists of two well-defined communities: the four vertices denoted by squares, including vertex A, and the nine denoted by circles, including vertex B.

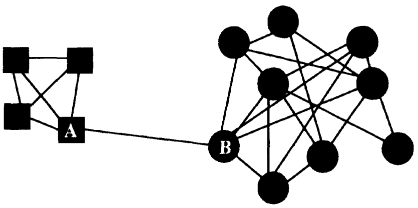

Figure 1: An example graph illustrating betweenness.

In the context of Figure 1, edge AB has the highest betweenness. If we were to remove it, the graph would split into two connected components, the square and circle communities. This illustrates the idea behind our method of imposing community structure on a graph: we repeatedly identify inter-community edges of large betweenness and remove them, until the giant component is resolved into many separate communities.

To find inter-community edges, we exploit Freeman's [Freeman, 1979] notion of betweenness centrality, or betweenness, applied to edges. The betweenness of an edge is defined as the number of shortest paths that traverse it. This property distinguishes inter-community edges, which link many vertices in different communities and have high betweenness, from intra-community edges, whose betweenness is low.

The removal of an edge strongly affects the betweenness of many others, and so we must repeatedly recalculate the betweenness of all edges. To do this quickly, we used the fast algorithm of Brandes [Brandes, 2001, Newman, 2001, Girvan and Newman, 2002], whose basic strategy is the following: Consider the shortest paths between a single vertex, the "center", and all other vertices. Calculate the betweenness of each edge due only to these shortest paths, and add them to a running total. Then change centers and repeat until every vertex has been the center once. The running total for each edge is then equal to exactly twice the exact betweenness of that edge, because we have considered all the pairs of endpoints of paths twice.

Our procedure stops removing edges when we cannot further meaningfully subdivide our communities; for example, as in Figure 1, after removing edge AB. What criterion tells us when to stop? As we remove edges, we divide the graph into many unconnected components. Structurally, a component of 5 or fewer vertices cannot consist of two viable communities. The smallest possible such component is size 6, consisting of two triangles linked by one edge (Figure 2). If

at any time we remove an edge from our graph and separate a component of size < 6, we can identify it as a community.

Components of size ≥ 6 can also be individual communities, like the group of 9 in Figure 1. To identify this type of component as a community, we use an intuitive threshold based on the betweenness of an edge connecting a leaf vertex, or vertex of degree one, to the rest of the graph. Consider the graph of Figure 3 below. It is clear that it consists of just one community. Applying the Brandes algorithm, we find that edge XY has the highest betweenness, indicating that the size of the largest distinct community within the graph has size 1. That is, there are no distinct communities within the graph.

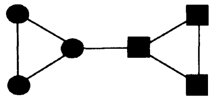

Figure 2: The smallest possible graph of two viable communities.

In general, the single edge connecting a leaf vertex (such as X in Figure 3) to the rest of a graph of N vertices has a betweenness of $N-1$, because it contains the shortest path from X to all $N-1$ other vertices. The stopping criterion for components of size ≥ 6 is therefore that the highest betweenness of any edge in the component be equal to or less than $N-1$.[1]

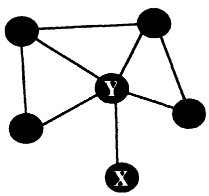

Figure 3: An example graph of one community that does not contain distinct sub-communities.

Multiple Community Structures

As mentioned above, the removal of any one edge affects the betweenness of all the other edges. Therefore, the order of removal of edges affects which edges are removed, particularly in large, real-world graphs such as the email graph. Early in the process, there are many inter-community edges which have high betweenness and the choice of which to remove, while arbitrary, dictates which edges will be removed later. We take advantage of this arbitrariness to repeatedly partition the graph into many different sets of communities. We then compare the different sets and aggregate the result into a final list of communities.

Identifying many community structures, in the form of different sets of communities, and aggregating them into a final list provides a much richer result than simply partitioning the graph once. Consider the placement of John and Sarah in communities. If John appears within the same community in all 50 sets, it is clear that John definitely belongs to that community. The order of edge removal had no effect on him. However, if Sarah appears in one community in

[1] It is not in general true that an inter-community edge must have betweenness greater than N-1. For a community of size m within a graph of size N, there is a total betweenness of $m(N-m)$ divided among the edges connecting the community to the graph. So, if there are more than m such edges, it is possible that none of them will have betweenness greater than N. However, remember that none of these edges, or the extra-community vertices they connect, should be adjacent, because then m would not be a community. This type of situation is extremely unlikely in a power law graph of degree ~ 2, such as the email graph.

some sets in another (or even several others) in other sets, the order of edge removal did affect her and we should consider that she has some affiliation with those two (or more) communities. Had we only considered one community structure, Sarah would have been placed in one community, rather arbitrarily, and we would have lost information about her role in the other community (communities).

The small graph of Figure 4 illustrates the mechanics of the placement of a vertex such as Sarah (vertex B in the graph) into a community. The graph consists of two communities, one on the left including vertex A, and another on the right including C. Among its edges, BC initially has the highest betweenness, and AB's betweenness is also high. If we choose to remove BC first, AB becomes an intra-community edge with low betweenness which will never be removed, and vertex B will eventually be placed in a community with vertex A. Had we removed AB first, BC would have been rendered intra-community, and vertex B would end up in the community with C.

Moreover, in considering Figure 4, it is not clear where B should end up. In fact, from the graph alone, B could rightfully be considered to be a part of both communities. The choice of one or the other is made early in the process, arbitrarily, when either edge BC or edge AB is removed.

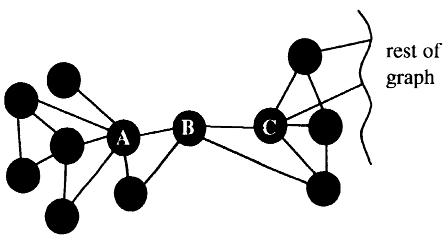

Figure 4: An example of a denser community subgraph. Ambiguity is introduced by the sequence in which edges are removed.

However, the arbitrary nature of this choice is a help rather than a hindrance if we use it to partition the graph repeatedly into different, plausible structures. We introduce the randomness into our algorithm in the following way. In partitioning a large connected component of vertices, instead of using every vertex as the "center" once, we cycle randomly through at least m centers (where m is some cutoff) until the betweenness of at least one edge exceeds a threshold, again based on the betweenness of a "leaf" vertex. We then remove the edge whose betweenness is highest at that point, and repeat until we have broken the graph into communities, identified by the criterion described above. We only do this for large components, using the full Girvan-Newman algorithm for small ones. The modified algorithm may occasionally remove an intra-community edge, but such errors are unimportant when one compares a large number of community structures.

Applying this modified process n times, we obtain n community structures imposed on the graph. We can then compare the different structures and identify communities. For example, after imposing 50 structures on our graph, we might find: a community of people A, B, C, and D in 25 of the 50 structures; a

community of people A, B, C, D, and E in another 20; and one of people A, B, C, D, E and F in the remaining 5. We report this result in the following way:

A(50) B(50) C(50) D(50) E(25) F(5)

which signifies that A, B, C, and D form a well-defined community, E is related to this community, but also to some other(s), and F is only slightly, possibly erroneously, related to it. For details of the aggregation procedure, please see [Wilkinson & Huberman, 2002].

The entire process of determining community structure within the graph is displayed in Table I.

A. For i iterations, repeat {
1. Break the graph into connected components.
2. For each component, check to see if component is a community.
a. If so, remove it from the graph and output it.
b. If not, remove edges of highest betweenness, using the modified Brandes algorithm for large components, and the normal algorithm for small ones. Continue removing edges until the community splits in two.
3. Repeat step 2 until all vertices have been removed from the graph in communities.
}
B. Aggregate the i structures into a final list of communities.

Table 1: Algorithm for determining community structure

Results

We performed an experiment of our algorithm using email data from the HP Labs mail server[2]. Starting from an original set of 878,765 logged emails over the period 25 November 2002 to 18 February 2003, we constructed a "clean" subset of 185,773 emails between any two of the 485 current HP Labs employees. For reasons of privacy and complexity, we neglected emails that had an external origin or destination. We also excluded messages sent to a list of more than 10 recipients, as these emails were often lab-wide announcements (rather than personal communication), which were not useful in identifying communities of practice.

From this data, we created a graph as described in the previous section. We used a threshold of 30 messages - that is, a pair was linked by an edge in the graph if and only if the two individuals had exchanged at least 30 total emails in

[2] This experiment was performed using a 900 MHz PC (1 GB of RAM) running the Linux operating system, and ran for approximately two hours.

our dataset, and each had sent at least 5 emails to the other (to reduce the number of one-way relationships). This threshold excluded some individuals who either sent very few emails or used other email systems. The graph thus created consisted of 367 nodes, connected by 1110 edges.

size of component	number of such components
343	1
8	1
4	2
3	2
2	1

Table 2: Connected component sizes in email graph, threshold 30

This graph was power law in degree, as mentioned above, with exponent 3.15 (Figure 5). It consisted of one giant connected component of 343 nodes and many smaller components ranging in size from 2 to 8 (Table II). We applied our algorithm as described above to identify the communities within the graph.

66 distinct communities were detected, including the small components. The largest community consisted of 57 individuals, and there were several communities of size 2. The mean community size was 8.4, with standard deviation 5.3. Comparing these communities with information from the HP corporate directory, we found that 49 of the 66 communities consisted of individuals entirely within one lab or organizational unit. The remaining 17 contained individuals from two or more organizations within the company.

Example community	
Individual	Strength in community (max 50)
Person 34	50
Person 267	50
Person 56	50
Person 406	50
Person 212	50
Person 246	29
Person 331	15
Person 87	7

Table 3: An example community from our results

We demonstrate the form of our results in Table III, which shows a sample community from the list produced by applying our method to the HP Labs email graph. The login names have been disguised for privacy; individuals have been randomly assigned an identification number. We performed 50 iterations of the modified Brandes algorithm described above to partition the graph into 50 different structures, and aggregated these structures into a list of communities. "Strength in community" is a count of how many times an individual belonged to a particular community after the graph was partitioned. In this particular case, five people were placed in the community in every iteration, while three others were only sometimes grouped into the community.

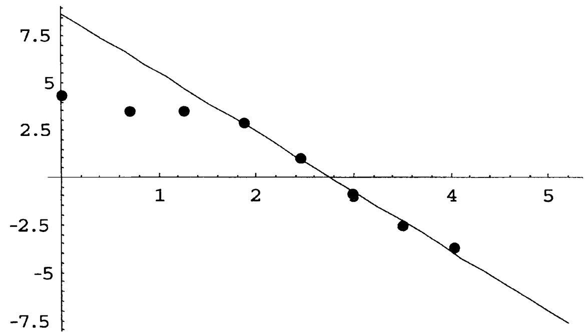

Figure 5: The number of vertices (y-axis) is plotted against the degree of the vertex (x-axis) for the email graph, threshold 30, on a log-log scale. We followed a typical exponential binning procedure in plotting the data [Newman, 2003]. The deviation from the power law for low vertex degree is to be expected in a small sample, and has little effect on the topological properties of the graph.

Identifying Leadership Roles

In addition to formal and informal work communities, it is also possible to draw inferences about the leadership of an organization from its communication data. With the ubiquity of electronic communication, one might expect that it would flatten out the corporate hierarchy—that the structure of an organization would not be visible in, for example, email log data. Sproull and Kiesler, in a relatively early study of email usage, found that email reduces social context cues, such as the relationship between managers and subordinates, and promotes "status equalization" within the medium [Sproull & Kiesler, 1986].

We have found, however, that although this equalization may occur in email *messages*, the organizational hierarchy is (at least somewhat) visible in the email *network*. We constructed a graph of the HP Labs email network with a standard force-directed spring algorithm [Fruchterman & Rheingold, 1991], shown in Figure 6[3]. The vertices have repulsive forces between each other, and the edges are springs pulling together the vertices at either end. This spring layout of the email network does not use any information about the actual organization structure. Each vertex represents an individual, and each edge signifies that the total email sent between the two connected vertices exceeds a given threshold (30 messages total in the 2½ months of data, with a minimum of 5 from each, the same thresholds used in the community discovery algorithm).

The graph has also been color-coded—the redness of a vertex corresponds to closeness to the top of the organization hierarchy for the individual the vertex represents. There is one totally red vertex (RGB value 255,0,0) representing the

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[3] The layout was done with Zoomgraph, a zoomable graph layout and network analysis tool, available at http://www.hpl.hp.com/shl/projects/graphs/

lab director. The bluer a vertex is, the more hierarchy levels separate the represented individual from the lab director. The maximum depth in this network is six levels from the lab director.

Visual inspection of the graph reveals the organization leadership tends to end up in the center—the reddest vertices are in the center of the graph. Measuring distance from the center of the graph provides evidence of this trend. Table IV shows the average hierarchy depth (levels from the lab director) for groups at increasing radii from the center. The first set of vertices is all those lying within a circle of radius 0.1 of the center, the second set is those of radius 0.1 to 0.2, and so on, where the height and width of the graph are 1.

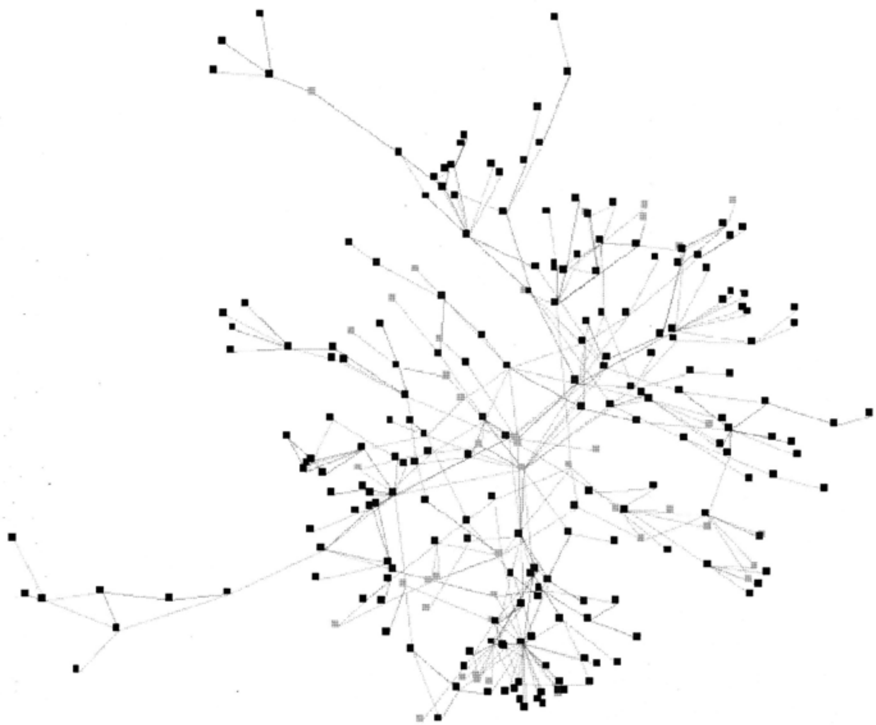

Figure 6: The giant connected component of the HP Labs email network. The redness of a vertex indicates an individual's closeness to the top of the lab hierarchy (red=close to top, blue=far from top, gray=no data available).

Distance from center	# of vertices	Average hierarchy depth
< 0.1	23	2.05
0.1 to 0.2	71	3.43
0.2 to 0.3	91	3.88
0.3 to 0.4	83	4.01

Table 4: Average hierarchy depth by radius from graph center.

Applications

Evaluating communication networks with this technique could provide information about leadership in communities about which little is known. Sparrow proposed this approach for analyzing criminal networks [Sparrow, 1991], noting that "Euclidean Centrality is probably the closest to the reality" of the current criminal network analysis techniques. More recently, Krebs applied centrality measures and graphing techniques [Krebs, 2002] to the terrorist networks uncovered in the 9/11 aftermath. In both of these cases, however, the links between entities were added manually. Our results suggest that meaningful insights about organization leadership can be drawn automatically from a simple record of communication interactions.

Field Evaluation

In order to validate the results of the communities identified by our algorithm, we conducted a brief, informal field study, consisting of personal interviews with sixteen individuals within our research lab (our experiment's population). In these interviews, we presented the subjects with the community or communities in which they were placed by the algorithm, and then invited them to comment on these results.

Interview Technique

Interviews were conducted in the subject's office, and lasted from 5-30 minutes, with an average of around 15 minutes. The interview was structured by a few open-ended questions, intended to provoke discussion. First, the subject was asked to characterize the community in which he or she appeared—did it "make sense," and if so, how it could be described, in the subject's own words. Then, once the subject had defined the nature of the community, we asked if there were any people missing from the community, or if there were people in the community who should not have been. Finally, we asked for more general comments on the plausibility of this community.

The interviews were recorded with handwritten notes from two joint interviewers. Following the interviews, these notes were compared and analyzed to identify consistent issues. In this paper, we present some representative quotes from our interviews as a way of illustrating some of our findings. Where there was diversity in the responses, we offer multiple examples representing the various perspectives articulated.

Results

We interviewed sixteen individuals in seven different communities. The communities were chosen arbitrarily to give us a representation of various community sizes and levels of departmental homogeneity. They ranged in size from four to twelve people, and three out of the seven were heterogeneous (included members of at least two different departmental units within the company).

All sixteen subjects gave positive affirmation that the community reflected reality. More specifically, eleven described the group as reflecting their department, four described it as a specific project group, and one said it was a discussion group on a particular topic.

Nine of the sixteen (56.25%) said nobody was missing from the group, six people (37.5%) said one person was missing, and one person (6.25%) said two people were missing. Conversely, ten of the sixteen (62.5%) said that everybody in the group deserved to be there, whereas the remaining six (37.5%) said that one person in the group was misclassified.

Departmental Communities

As expected, our interviews confirmed that many, and perhaps most, of the communities identified are based on organization structure. Some responses to seeing the generated communities were "yes, that's my department," "this is a group that reports to me," and "that's pretty much our project team."

However, the communities also tended to include people who were de facto department members, but who did not technically appear in the department's organization chart, such as interns or people whose information was out of date. For example, one person said of his identified community, "One of these was an intern, and the rest are in the same group."

Finally, the algorithm seemed to succeed in dividing departmental groups whose work is distinct, but lumped together groups whose projects overlap. For example, one manager said, "This is one category of my direct reports... I have two groups of reports... The two groups are separate. They don't meet together and they don't work together." By contrast, in our largest group of twelve, the three people we interviewed all informed us that the group comprised their entire department, and that they don't work with all eleven other people. However, one also said, "there tends to be a lot of overlap in the projects in our department."

Informal Project or Discussion Communities

We were particularly interested in exploring the heterogeneous, cross-department communities that were identified. We found that most of them represented groups formed around specific projects, and in one case, a discussion forum.

In one case, we found a community containing three people from different labs coordinating on one project. This group included a technology transfer project manager, a researcher who was the original designer of a piece of PC hardware, and an engineer redesigning the hardware for a specific printer. As the engineer described it, "This is a printer board project... I'm completely out of this group, organization-wise. They don't have engineers that will build this kind of stuff [he holds up a printed circuit board]."

Another interesting example was that of the discussion-based community. One subject in the group said, "It's interesting that this is not an administrative group. I've been part of a discussion forum on multimedia networking... Your algorithm is good at identifying the people I do my technical work with." She continued to explain that she thought the eight-person community was accurate for her discussion group, even though six of the eight were on a shared email list that the other two were not.

Communities of Practice Have Leaders

In our interviews, we discovered one similarity in all seven communities: The presence of a leader or manager of the group. In the departmental communities, this was the department manager. From the smallest department we identified (four people) to the largest (twelve), the manager was included in the community. In the more informal communities, the subjects identified a person who was the manager or coordinator of the group. In the printer hardware project example described above, this was the technology transfer project manager (which was confirmed by all three interviews in this group).

Another community was formed around work related to a recent merger completed by the company. In this community, one person from the lab director's office joined with five people in the lab finance department, and became the leader of this project.

Discussion

The power of this method for identifying communities and leadership is in its automation. We have found that it does an effective job of uncovering communities of practice with nothing more than email log ("to:" and "from:") data. Its simplicity and suitability for scale-free networks means that it can be applied to organizations of thousands and produce results efficiently. Furthermore, it also applies to other forms of communication, such as instant messaging, telephony, SMS-style text messaging, and mobile device usage.

This technique is a useful complement to existing strategies for identifying communities of practice. In cases where an organization is very large, widely dispersed, or incompletely defined (informal), this method provides an alternative

to the more traditional, labor-intensive approaches. Our empirical test with nearly one million messages from an organization of 400, using only a desktop PC, suggests that it would be simple to scale this analysis up to organizations of many thousands.

As discussed previously, an intriguing application of this technique is in the area of intelligence and covert networks. For these "organizations", which have no official documented structure, the identification of communities and potential leaders in this way, based on communication records, could prove useful. Sparrow [Sparrow, 1991] and Krebs [Krebs, 2002] both explore this concept, but to date there has not been (at least in the public domain) a treatment of a very large informal organization.

Limitations

As with any evaluation of centrality measures, defining the organization population is important. In a setting like a corporate lab, this is easy—the membership is clearly defined. In an informal network, however, this is much more difficult. In addition, disambiguating redundant names or IDs is a tricky task. Within HP Labs, we were able to use the corporate directory to accomplish this in creating our "clean" dataset, but in an informal network, without such a reference, it would be much harder.

Since a computer generates them, the communities we identify lack the richness in contextual description provided by ethnographic approaches. We do not know the nature or character of the identified communities, the relative importance of one community to another, or the subtle inter-personal dynamics within the communities. These kinds of details can only be uncovered with much more data- or labor-intensive techniques.

Finally, we found that in some cases this algorithm can make mistakes. We found that a few of the communities in our experiment contained misclassified individuals, and some were missing individuals who should have been included.

Future Work

We are particularly interested in extending our analysis of communities to include a temporal dimension. Our email data also includes a timestamp of when email was sent, enabling us to build communities based only on email from one particular week or one specific time of day (e.g. the "Monday morning" communities). We plan to investigate how community membership changes over time, such as from week to week or from day to day within the week.

We are also improving our understanding of how to set the threshold on which data to use. Currently, we have a finite threshold of 30 messages between a pair of individuals, which neglects the fact that some people send more email overall than others. We are exploring thresholds based on percentages and variances of

email traffic, as well as comparing the communities generated by using different thresholds.

Finally, we are attempting to expand our dataset to include more HP employees outside just HP Labs. Testing our technique on an organization of 150,000 people, or at least a significant portion thereof, will demonstrate whether it scales effectively to very large organizations.

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Multimedia Fliers: Information Sharing With Digital Community Bulletin Boards

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Abstract. Community poster boards serve an important community building function. Posted fliers advertise services, events and people's interests, and invite community members to communicate, participate, interact and transact. In this paper we describe the design, development and deployment of several large screen, *digital* community poster boards, the Plasma Posters, within our organization. We present our motivation, two fieldwork studies of online and offline information sharing, and design guidelines derived from our observations. After introducing the Plasma Posters and the underlying information storage and distribution infrastructure, we illustrate their use and value within our organization, summarizing findings from qualitative and quantitative evaluations. We conclude by elaborating socio-technical challenges we have faced in our design and deployment process.

Introduction

Technological advances in networking and display technologies, combined with cost reductions, have resulted in the placement of many large-screen, digital displays in public places for advertising and information distribution. A recent example is the AdSpace Network's CoolSign, which "utilizes multimedia displays to offer advertisers a vehicle with the impact of print, the pull of television, and the immediacy of the web." Most of these systems present information on minimally interactive displays and are intended for distributing carefully crafted, broadcast content. Within the workplace, and more informally, large screen, publicly visible displays are being used as memory aids (e.g. Fass *et al.*, 2002), and to offer awareness of colleagues' activities within small working groups (e.g. Greenberg and Rounding,

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2001; Huang and Mynatt, 2003). Capitalizing on touch-screen interaction capabilities, public displays are also being used for focused, task-centered, collaborative work (e.g. Guimbretiere *et al.*, 2001; Klemmer *et al.*, 2001; Pederson *et al.*, 1993; Russell *et al.*, 2002; Streitz *et al.*, 1999).

In this paper we describe our work on the design and deployment of the Plasma Posters, large screen, digital poster boards that display community-generated interactive, multi-media content in the physical environment. Inspired by the use of physical poster boards in social spaces (see Figure 1), such public community technologies are designed for people who, at least on occasion, occupy or move through the same geographical location. They blur the notional "boundary" between virtual and physical locales of communication, and take advantage of the fact that relationships usually take place offline as well as online (Wellman, 1999).

The intent behind the Plasma Posters is to stimulate unplanned social interactions around digital content and thus provide opportunities for discovery of shared interests. Such conversations are central in establishing and strengthening social ties (Granovetter, 1983). This work sits within the same design space as research carried by Houde *et al.* (1998) who projected a digital newsletter created by members of a research group into a common gathering space, and Snowdon and Grasso (2001) who describe the "Community Wall" (CWall), a community bulletin board that displays community rated research papers and news in public spaces.

Figure 1: Community boards: in the launderette; on the street; in the workplace

In the sections that follow, we present results from our fieldwork on the use of informal poster boards, and describe the design, deployment and use of the Plasma Posters within our organization. We conclude with reflections on socio-technical challenges encountered in this deployment, and offer some future directions for our work.

Fieldwork: Information Sharing with Public Displays

Posted paper fliers are a mode of asynchronous communication that utilize the physical environment as their canvas or stage. They take advantage of the movement of people through social spaces, and are thus part of "the interplay of human activity with the physical place" (Jacobs, 1999, p6). Such poster boards are part of the fabric but not the infrastructure of a social space; in Brand's terms the poster boards are part of the malleable "space plan" of a space, with the posted fliers part of the "stuff" that "twitches around daily to monthly" (Brand, 1994, p13). However, while there has been much written about designing the physical environment to encourage interaction, social engagement and community identification (e.g. *streets*: Jacobs, 1961; Jacobs, 1999; Whyte, 1971; *public spaces, bus stands, waiting rooms, interior gathering places*: Alexander *et al.*, 1977; *work places*: Albrecht and Broikos, 2000), there has been little written about the placement and use of community poster boards within these social spaces, or on the effect of such community poster boards in promoting social ties and encouraging community identification[1]. Therefore, our design process began with consideration of information sharing within communities, and in particular the use of physical poster boards in such communication practices. Observations from two field studies are presented below.

Our first study was intended to elaborate a design space for the design of digital poster boards, based on consideration of the placement and use of physical, poster boards in public settings. For the purposes of this study we defined "public" to be on a continuum from "unrestricted" (e.g. streets) to "restricted" (e.g. small group, closed workplaces). The second study focused on our own workplace, the site of our first technology deployment. Observations from this study were aimed at generating specific design instances as appropriate for our use community, but also to establish whether there was a 'natural' role for digital, public, poster boards as a content sharing technology within our lab; that is, if there was a potentially good "match" between the technology and communication styles within our lab (Bly and Churchill, 1999; see also Harper and Carter (1994) for an instance of a bad "match" between a social milieu and technology features).

Study 1: Community bulletin boards in public spaces

We investigated the use of poster boards in unrestricted, "open", public spaces (e.g. cafes, sports clubs and streets) in three local areas (Palo Alto, and two districts of San Francisco), talked to local inhabitants, and interviewed six local community members in depth about their use of and views regarding public poster boards. In addition, we

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[1] However, much has been said about the vital role of community print media in the form of local newspapers (that include classified ads, which in many instances are the print version of community bulletin board content) in this regard (e.g. Stamm and Fortini-Campbell, 1983; Tripp, 1994).

observed the use of public poster boards within three workplaces as instances of content sharing in more restricted public settings (a research center, a technology sales office and a technology start-up). Our observations focused on: (1) board location and form/degree of access; (2) content analysis of posted material; (3) usage (observing people reading from and posting to the boards); and (4) people's perceptions of poster boards.

Observations of "open" area boards

Poster boards are typically placed (1) where people are likely to have time on their hands while they wait for some other event (e.g. doctor's waiting rooms, train and bus stations, bus stops, barber shops, launderettes); (2) where people intentionally go to relax, pass the time and socialize (e.g. cafes, see Oldenburg, 1989); (3) where people go to intentionally seek information (e.g. local libraries, community center information rooms); (4) where people routinely go to pursue leisure activities (e.g. tennis clubs, gyms, community event centers, Oldenburg, 1989); and (5) where people routinely walk (e.g. corridors). Poster boards vary in size; this has consequences for how content is displayed. Unsurprisingly, materials for poster boards and posted content vary depending on location (more cork indoors; more plastic fliers outdoors). Some boards are more physically accessible than others.

Interviews with local residents indicated that poster boards serve an important communication function within communities. They provide a means for people to seek and advertise viewpoints (e.g. support for political candidates; rejection of current economic policies), activities (e.g. join our band), events (e.g. come to the local Arts and Wine Fair; invitations to political rallies) and services (e.g. babysitter wanted, carpool partners sought). Community members felt these boards provided an important function in demonstrating the vitality of their neighborhoods.

Loosely speaking, the boards provide a sense of the community "personality", reflecting the preferred activities and the needs of the local inhabitants. Content analysis revealed that poster boards in the Mission District of San Francisco advertised dance and cooking classes, English lessons, yoga classes, religious gatherings and political meetings, while nearby Noe Valley poster boards sought and advertised babysitters, dog walkers, hiking partners, lost pets, Pilates classes and, again, yoga classes. Content variations can also be seen at a finer grain, by local context within neighbourhoods (e.g. dance class posters near to dance studios), and in terms of *temporal scope of relevance* (i.e. some things are only relevant for a short period of time while others offer content that has ongoing relevance). Posting genres were visible: 'accommodation wanted' ads tended to be on small cards; announcements for events tended to be larger and on colored paper; items for sale were often accompanied by tear-off tags with phone numbers and email addresses; lost pet fliers were usually accompanied by a photograph. Posted content varies in terms of its *intended outcome* with regard to others' actions; some fliers solicit action (come to the dance class), some solicit transactions (buy my car), some seek

information (anyone seen my cat?), and some inform (stray cat found). The physical properties of fliers often relate to these intended outcomes (e.g. multiple postings and tear-off strips indicate content is to be taken away from the board). Posting types therefore have different affordances for action (Norman, 1988) and thus engender different (re)actions from readers (e.g. reading, writing down information such phone numbers or event times, referring content to others).

Although content is usually designed to be eye-catching and noticeable, postings vary visually; some boards impose *branding* (some poster boards require fliers to be in specific formats) while others do not (fliers show a great deal of creativity and are highly *individual* or personal in terms of size, colours used, images used, fonts, use of tear-offs strips, etc). Related to the last point, forms of moderation for poster boards map to those for online electronic bulletin board systems: from *formal and moderated* (items can only be posted by asking a "gatekeeper's" permission; someone regularly "garbage collects"; items tend to be in prescribed formats), to *reviewed and informally monitored* (checked over regularly; sometimes cleared by various people), to *open* (anyone can post anything, in any format, anytime; old posters seldom cleared off). Posted items in the latter two cases tended to demonstrate the greatest variety.

Observations of "closed" area, organizational poster boards

Informal poster boards within three local organizations (two research laboratories (~200 people and ~40 people) and one ~40-person technology start-up) also varied between moderated and open. Content was often related to competitors' activities, conferences, upcoming events, and recent news articles. Even in the two smaller organizations, people seldom had any idea of who had posted informal content. People were positive but less overwhelmingly enthusiastic about the presence of poster boards than the "external" community members we interviewed. Items were posted when persistent visibility was deemed to be more effective (unlike emails), or when materials already existed in paper form (e.g. photographs of holiday home rentals or cars for sale). The degree of enthusiasm appeared to correlate to the size of the organization. People in the smaller organizations were more likely to send email or talk face-to-face, so felt poster boards were simply an addition, and that other means of contact were likely to be used. People in the large organization felt inhibited sending emails to people they didn't know, being uncertain of others' standing in the social hierarchy or their tolerance for unsolicited emails. Hence, they felt that posting content to poster boards was more socially appropriate and did not risk being an unwanted intrusion.

Summary

Our observations of community boards in public areas and in organizations suggest a number of important dimensions along which boards vary. Dimensions relate to (1) board location, (2) social and material characteristics of boards, (3) social, material (particularly affordances for (re)action), and textual properties of content, and (4)

people's actions with regard to content (considering readers and administrators, and including placement, administration, moderation and consumption).

Study 2: Information sharing within FXPAL

FX Palo Alto Laboratory (FXPAL) is a software research company based in California, and is a subsidiary of Fuji Xerox, Japan. At the time of our study, there were 34 full-time employees at FXPAL. Twenty-five are full-time researchers drawn from diverse disciplines (e.g. computer science, psychology, engineering, linguistics), 6 are administrative staff and 3 are technical support staff. In addition, there are 14 contractors/consultants, in full and part-time capacities. Student interns and visiting scientists are also present during summer months. Researchers work in separate project groups; there are 7 such groups, with little overlap in membership. The lab is located on the first floor of a two-storey building. All full-time researchers have their own offices. Contractors/consultants have offices or booths, and interns have either booths or desk space within a large, shared room.

Our study was in three parts. First, we mapped the lab space using floor layout charts. Then we observed/photographed activities in public areas, noting people's movement through the building. Following, this we engaged 17 people in a photograph and text diary study with subsequent interviews about their online and offline information sharing practices within the organization. Two administrative staff, 2 summer interns, 2 contractors/consultants, 3 support staff and 8 researchers took part in the study. Interviews were semi-structured and lasted between 30 and 90 minutes.

Observations

In accord with other studies, our observations confirmed that people are not always at their desks, but are often locally mobile, moving physically around the building (Bellotti and Bly, 1996). People engage in "water cooler", informal conversations (Whittaker *et al.,* 1994). Given our interest in content sharing in public spaces, we analyzed the use of *corkboards and paper postings.* There are 7 corkboards in the building; most are in corridors, one is located in the kitchen area and another in the mailroom area. As with the external community boards, each poster board has a different "personality"; one is dedicated to the display of items that are legally required to be on view (located in the mailroom), one is dedicated to newspaper clippings of interest (e.g. from the Nikkei Weekly), one is dedicated to conference and journal announcements, and the others are more informal, displaying jokes, ticket reductions for local events, and lunch menus.

Our analyses demonstrated that people's interest *is* piqued by others' postings in the physical environment. Most of our interviewees thought they were a valuable resource and that the environment would be "sterile" without them. Boards that changed frequently were deemed to be most interesting and eye-catching, and that

posted content was considered to reflect the "identity" and "milieu" of the lab. Events, such as presentations and visitors, and items posted on corkboards occasionally spark *in situ* conversations. People said they were sometimes pleasantly surprised to discover mutual interests with other colleagues when such conversations took place. The most read corkboards were those in areas where people were waiting or engaged in low concentration tasks such as waiting for printouts or coffee to brew, although hallway corkboards were also glanced at and sometimes referred to as people moved about the building. The 3 that are posted to and read most frequently are the conference announcement board, the newspaper clipping board and the kitchen-based, informal board. Four perceived problems with corkboards were expressed: (1) the presence of out-of-date materials – it is sometimes hard to tell what was still relevant; (2) interesting content sometimes "disappears" before it has been read; (3) it is hard to tell who posted material, so follow-up conversations are difficult to initiate; and (4) information on corkboards is not easy to copy and/or easily access digitally for later follow-up (e.g. URLs). This comment clearly reflected the fact that most information sharing occurs via computer. Therefore, to provide context for the use of poster boards as an information sharing resource we also interviewed people about other methods for information sharing.

As suspected, online sharing is strongly preferred, being seen as low overhead, given most people are working at their computers most of the time ("it doesn't take much effort to forward a link"). However, such online sharing tends to occur between members of *established* project and social groups. Little social mingling occurs through electronic media, and few opportunities arise for serendipitously discovering shared interests. *Email* is by far the most frequently used means of communication, although some people complained about email overload (see also Whittaker and Sidner, 1996). Email is used for coordination, to share formal and informal information, send announcements, and share ideas and interests. Most emails are sent to small sub-groups and targeted individuals. When interviewees were asked about sending company-wide emails on things that may be of general interest, a reticence was apparent. Email is perceived to be socially risky and a potential intrusion into people's personal digital space, so people err on the side of caution. As one person phrased it, "I don't want to fill other people's email boxes up with things that may be of peripheral interest to them. People get irritated". *Intranet web pages* are used for general administrative purposes and within projects for recording activities and research results. People seldom browse the intranet to learn about projects and colleagues' interests (one new person to the organization reported doing so). Use of the intranet tends to be for directed information access. *Presentations, seminars and reading groups* are used to share ideas about research areas and research results. On occasion, supporting materials are disseminated. Presentations tend to be company-wide, while participants in seminars and reading groups tend to be members of established teams. *Chats* in the hallways are a means of hearing about formal and informal information. These take place where people are waiting (e.g. the kitchen

area, by printers), passing time (e.g. by the magazine racks) or doing low concentration tasks in public areas (e.g. photocopying, checking mailboxes) (Whittaker *et al.*, 1994).

Summary

Study 2 revealed that communication and content sharing with colleagues outside project and social groups is seen as valuable within our organization, but does not occur as frequently as is desired. People are routinely at their desks and accessible via online communication tools, but are also mobile within the building. Although all areas of the building are passed through, there are clearly identifiable gathering places, and places people spend time "idling" or waiting. People commonly share digital content within established groups. People seldom post physical fliers because of the "overhead" of producing them and/or placing them, and because digital communication tools are literally "at their fingertips". We concluded that digital poster boards could represent a new genre of informal, "lightweight" communication medium within FXPAL, leveraging the existing bias for electronic communications, and providing a less intrusive, more public method (not direct to others' email InBoxes), for sharing content. We predicted content posted on such bulletin boards would not have been previously shared lab-wide, and would provide new opportunities for conversation between lab members.

Issues for Design

Study 1 illuminated a number of dimensions along which public poster boards and practices surrounding their use tend to vary. These dimensions were used to elaborate a design space for creating and placing digital bulletin boards. Study 2 suggested digital bulletin boards could have a place within our organization. Specific observations from this study were also used to refine, elaborate and instantiate design possibilities raised in study 1. The following design guidelines were generated and characterized according to the areas identified in study 1: board location; social and material characteristics of boards; social, material and textual properties of content; and actions on content.

Location options are somewhat limited given digital bulletin boards are more fragile than physical bulletin boards. Whilst acknowledging that constraint, place digital community bulletin boards in relatively high traffic areas and in spaces where people may be passing by, waiting, "idling" or socializing. Be aware of interactions between location, content type and people's actions on content (e.g. directed information seeking versus noticing-in-passing as part of "everyday life information seeking" (Savolainen, 1995)). Consider ease of (physical) access to boards for reading (make sure people can reach interactive content), and for posting (i.e. make posting low effort by using tools for content sharing that are already familiar, such as email and the Web; see also comments by Houde *et al.*, 1998).

Boards must be interactive to maintain the feeling of direct interaction with content. Design interfaces to emphasize content and for viewing in public places; move away from the desktop metaphor of personal computers. Board size (as with physical poster boards) restricts what can be shown at one time; design interfaces that cycle through information. Allow people to easily see content that is currently stored in the system but that may not always be visible; that is provide an easy way to get overviews of what has been posted.

Content must be attractive, and take into account screen resolution. Design inviting interfaces where content changes regularly, and make content easily readable from a distance. Digital content may include animation and interactivity; investigate what is likely to be posted and design to support as many file types as possible for the context of placement. Consider providing for author personalization in content appearance (e.g. personal "skins" around content or fonts), and/or possibilities for imposing board owner "branding"; consider trade-offs between these two models for the specific context of placement. Develop easily recognizable genres for different forms of content.

Practices around content must be taken into account. Provide a means for digital fliers to be commented on. Provide a means whereby postings of interest can be easily "taken away" and shared; i.e. printed or forwarded (to others or to oneself). Since digital content can easily be stored, provide a community repository or memory of postings that may be browsed after public showing of the content has expired. Unlike paper flier content, digital information can be accessed from distant locations and may require reformatting for other devices. Associate content clearly with people who have authored/sent that content to encourage communication between people; this has the added benefit of introducing social accountability which may prove a deterrent to posting "inappropriate" content. Provide means for content to be grouped and associated. Explicitly consider moderation policies; that is, consider restrictions on who can post, and how posting permission will be administered, and whether content will be monitored. Support easy administration and garbage collection of posted content, both for system developers, and for community members.

In the next section we describe our initial prototype, the Plasma Poster Network, where a number of these design guidelines are instantiated.

The Plasma Poster Network

Plasma Posters are plasma displays with interactive overlays that enable direct touch interaction. We placed three Plasma Posters in our lab, one in the kitchen area, one in a foyer and one in a hallway (see Figure 2). Inspired by the aspect ratio and layout of paper posters (Timmers, 1998), Plasma Posters are oriented in portrait format, distinguishing them from other plasma displays. Underlying the Plasma Posters is the Plasma Poster Network, a content storage and distribution infrastructure that posts content to all registered Plasma Posters. We first describe the interfaces that have been

iteratively designed over the last year to suit the needs of our local community members, then offer a brief overview of the underlying infrastructure.

Figure 2: Plasma Posters are located in a corridor (left), a foyer (middle) and the kitchen (right)

Content, Interfaces and Reading Practices

Posting Content: The Plasma Poster Network stands in contrast to the deployment of advertising bulletin boards and digital poster boards, where non-interactive content is centrally authored and/or moderated, broadcast and displayed for an audience of consumers in public spaces. Rather, content that is displayed on the Plasma Posters is generated from two sources: content that is explicitly posted by individuals, and content that is automatically retrieved from selected intranet Web pages (e.g. announcements of new technical reports, announcements of upcoming meetings). To support the former case, we have implemented applications that allow authenticated community members to email items as attachments (text, URLs, images, digital movie clips) or post items from a Web. In using familiar tools like email and the Web, our intention has been to dovetail with existing content sharing tools and practices.

Displaying Content: Figure 3 shows the current "PosterShow" interface. The image on the left is a posting from a traveling colleague who has emailed images and some accompanying text as commentary. Any number of pictures can be posted; once displayed they can be zoomed, reduced and dragged. The image in the middle is posted text that has been formatted by the author. The image on the right is of a URL. Content can be scrolled and all links are live. Postings are by default removed after 2 weeks, but posting duration can be manually set. All postings and relevant meta-data (e.g. date of posting, duration posted and comments) are kept in the user's personal profile, accessible from a Web page, so old postings can be reviewed and reposted.

Reading content: Interactive, multi-media content on large displays in (relatively) public spaces is a different form of reader engagement with text than reading personal content from paper (O'Hara, 1996; Adler *et al.*, 1998) or from a personal reading appliance screen (Schilit *et al.*, 1998). However, analytic categories discussed in these contexts map fairly well to interaction with content on physical public poster boards (e.g. goal or task driven: skimming and active reading; undirected: browsing).

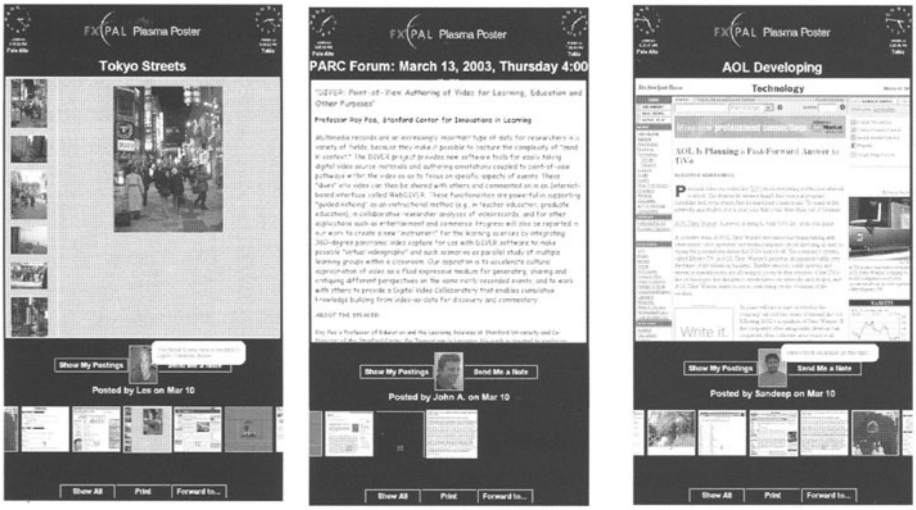

Figure 3: Examples from the "PosterShow" Interface: posted images, text and a URL. Author comments appear in speech bubbles by their photographs. Other content appears as thumbnails below the currently displayed 'main' posting. Bottom buttons are for overviews, printing and messaging.

Therefore, we have designed for the following forms of engagement with content:

(i) *peripheral noticing.* Public displays are a form of peripheral technology – until something catches one's eye when attention becomes focused and cognitive engagement with the text ensues. In the design of the Plasma Posters, effort has been expended in designing content to be visually attractive and to invite observation and interaction; display colors are selected to stand out in the local lighting conditions, animation and movement in the interface are supported, and large fonts give the gist of content from a distance. We take advantage of the dynamic properties of digital media; postings are cycled through automatically one at a time and displayed for 60 seconds. Given our focus on social networking and information sharing, all postings are augmented with contact information of the person who posted the content, the date/time of posting, and any additional audio or text commentary.

(ii) *(inter)active reading.* On traditional poster boards people manipulate posted pages on physical poster boards to be able to read content (lifting, moving aside), and take postings away to read later. On the Plasma Posters, content that is displayed can be *paused*, *scrolled* and printed. As noted, all interactions are touch-screen; interfaces have been designed to remove the need for virtual or physical keyboards. Touching the display (e.g. when scrolling) or selecting the pause button reinitiates the 60 second timer. Given digital content is hypertextual, we support the following of live Web links.

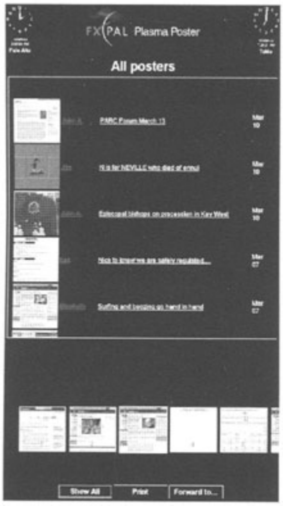

Figure 4: Scrollable content overviews by person, by posting date and by content help readers at the Plasma Posters browse posted content

(iii) *active browsing and searching* People remove physical postings to see what lies beneath. When they have noticed something previously, they sometimes come back to explicitly look for it. On the Plasma Posters, buttons are available for manually moving *forward* and *backward* through upcoming and previously displayed content. Browsing and navigating all items in the current list of postings is possible using with the *overviews* (Figure 4).

(iv) *messaging.* People remove physical postings to give to others, tear off tags and note down phone numbers, URLs and email addresses from physical postings for later follow-up. By selecting the 'forward' button and member photos from the member directory, items displayed on the Plasma Posters can be *forwarded* to one's own registered email address and/or to other people who may be interested. Comments may be emailed to authors[2]. As noted, content can be printed.

Implementation: Parsing, Storing and Distributing Content

The Plasma Poster Network is a client-server system that has been designed to make it easy for content creators to distribute information to their community. Server components provide the collection and hosting infrastructure. Client components provide a variety of content displays and interaction mechanisms.

The Plasma Poster server consists of the following components: a number of Java servlets that run in a standard Web server (e.g., Tomcat from the Apache Software Foundation); a relational database (e.g., MySQL from MySQL AB); a *ContentServer* Java application program controls access to the database using the Java standard interfaces (JDBC from Sun Microsystems). Servlets provide access to the Plasma Poster capabilities. *Overview* servlets provide representations of posted information organized for easy location and browsing of community content. Plasma Poster Web pages format the overview information into a variety of representations, including a tabular list, and tiled or overlapping image maps. *PosterMail* and *Posting* servlets allow posting of information to the Plasma Poster Network through email and through Web interfaces.

[2] At present, no authentication procedure is required at the board; members of the local community are trusted to identify themselves manually by selecting their own photo from the community member listings. However, implementing a badge-in mechanism or pin entry would be trivial.

A set of client components have been incorporated into the system, including: standalone applications; Web-based programs implemented as Java applets, and dynamic Web pages. The *PosterShow* Visual Basic application provides a cyclic view of posted content suitable for display and navigation on a Plasma Poster client platform (e.g., large plasma display or personal computer). *Annotation and mailer* clients allow free form responses made at a client platform to be distributed back into the user community (e.g., as a reply to the posting user or forwarding to others). Finally, Administration and Access Control Web pages allow us to easily maintain the content and metadata required by the system (for more details see Churchill, *et al.*, 2003).

The system facilitates the flow of information across the diverse sets of hardware and software upon which users conduct their online activities (i.e., linking email, Web interfaces, Web-based services, our own infrastructure services, and public and private device content representation services). The need to work within people's preferred working environments has lead us to adapt the behaviors of these other resources. One example of this approach for *repurposing* is the PosterMail servlet. Incoming email messages that users spend minimal time formatting (e.g., drag, drop, send) are parsed. Different content types (e.g., texts, movies, URLs, and collections of photographs) are detected and the content is appropriately arranged for presentation on the Plasma Posters (e.g., single frame, linked frames, or collages of content, with titles and commentary attached).

Use and Impact of the Plasma Posters

The Plasma Poster Network has been stable and used within our workplace for 6 months. Community activities have been logged, and qualitative evaluations carried out to document people's experiences, responses, and reasons for posting/non-posting. The qualitative evaluations were three interview-based evaluations (with 7, 10 and 8 interviewees respectively) and an email survey (with 23 respondents of which 13 had never or only once posted content to the Plasma Poster Network). These evaluations have provided us with ongoing user feedback regarding interface design and system features. In addition, the evaluation data are pertinent to our broader research questions regarding the potential in fostering social interactions for large screen, digital, community bulletin boards. For the purposes of the data analysis, we posed the following sets of questions:

1. **Relating to technology use**: Will people *post items* to share with others in physical spaces? Will people *read digital content* in public spaces? Do people *engage with content* on the Plasma Posters, and if so, are there *patterns of interaction by location and time*? What are *patterns of posting*?
2. **Relating to technology reception and impact**: Are the Plasma Posters perceived to be a *valuable addition* to existing methods of content sharing? That is, is content projected into the local physical environment seen as a valuable

addition to existing environmental and desktop methods of content sharing (e.g. corkboards, email and Web pages)? What are the most *popular forms of content*? What are *reasons for posting and non-posting*? Does content in the physical environment *cue conversations* between colleagues?

Posted content

Since the deployment of the current system 28 weeks ago, 501 postings have been sent to the Plasma Poster Network, with an average of 17.9 posted per week (range 1-43; sd 8.7; median 16; mode 14). This posting activity was generated by 28 people, again with an average of 17.9 postings per person (range 1-155; sd 32.7; median 4; mode 2). Nine people are responsible for the bulk of the posted materials (88.6%). All postings have occurred through email; nothing has been posted from the Web interface. During the first week of this deployment 14 items were posted. The greatest number of postings in a week was 10 weeks after deployment (43; mid October), and the fewest 2 weeks after deployment (1; mid August. Note that some adjustments were being made to the newly deployed system at that time). Most postings are during the working week (Monday-Friday; mean=98, sd=21), rather than the weekend (mean=5.5; sd=3.5). There are no significant differences between the days of the working week.

Three people have posted content when traveling (3 short reports, 4 conference announcements and 6 sets of photographs (see Figure 4), and one current events news article). Interview comments suggest these are very popular; authors and viewers feel a presence within the community is maintained by these postings. Posted content tends to be low urgency. Few items explicitly invite transactions or interactions (e.g. items for sale, requests for carpools, queries regarding related work are still are sent via email to targeted individuals). Content has varied from work-related to hobbies, and from general interest to company specific, including announcements of product releases and upcoming events, visitors, lunch menus and images from company events; 74% of the postings have been text or URLs, 25% have been images and 1% have been short movie clips. URLs largely consist of announcements for local and external events (e.g. conferences, movies, plays, sports), news items (unsurprisingly, often concerned with technology innovations), unusual examples of technology related products or designs, jokes and political commentary, interactive surveys, items of cultural or personal significance to the posting community member, book reviews and poetry. Not all content starts in digital format; several postings have been scans of paper materials. Although people can extend how long something is shown on the posters, almost all items posted are posted default setting and expire after 2 weeks. Re-posting has only occurred on a handful of occasions.

Interview and survey data revealed that content sent to the Plasma Posters would "probably not be emailed" to the lab-wide email alias, as people felt they wouldn't want to "fill up others' mailboxes" with things that may be of peripheral interest. These comments suggest to us the Plasma Posters do indeed provide a complementary

mechanism for content sharing within our lab. InBox cluttering from bulk email has been a common complaint in the organization even with work specific (e.g., technology innovation) or company sanctioned (e.g., product and organizational information) contents. This is not a complaint with the Plasma Posters. The most common reason for not posting was that people felt they didn't think others would be interested in their content ("I'm not sure what to post, my sense of humor is pretty different"; "my topics would be too boring"). People said they tended to share content with smaller groups; lab-wide visibility was not too risky ("with most things I would want to share with only a select group"; "I haven't come up with anything that would be of interest lab-wide yet").

Interacting with Content

We logged 22,201 user interaction events from the three Plasma Posters over 149 consecutive days (including weekends)[3]. People interacted with content that was on display on the Plasma Posters, but did not forward content or reply to content authors, although in interview people were intrigued by the potential of these features. Using the analytic categories outlined above, *(inter)active reading* accounts for 62.4% of all activity (scrolling content and following links; pausing content and printing); *navigation and browsing* for 35.4% (show all postings; resuming content cycling by pressing "Play"; show previous posting; show next posting) and *messaging* for only 1.3% of activity (replying to content authors; forwarding content to oneself or to others). Finally, 0.9% of activity was people looking for more information about content authors/posters.

Interacting with Content by Location and Time

Location makes a big difference to interaction. 67.9% of all activity occurred at the kitchen Plasma Poster, 19.8% at the hallway poster and 12.3% at the foyer poster. Table 1 shows the mean number of interactions per day broken down by the different Plasma Posters, and by reading, navigating and messaging activities. We are currently analyzing our interaction data by content type to establish whether different forms of content and different locations systematically invite particular forms of interaction.

Activity data reflect the working rhythms of the lab. Although the data in the tables include weekends, weekday interactions account for 99% of the data logged (weekday interaction events per day mean=205.9; sd=169.7; weekend mean=10.8; sd=8.2). Interview and survey data suggested people read content early in the morning and at coffee breaks. Our activity logs verified this; activity peaks are at 10am, 3pm and 4pm, and activity tails off around 6pm (not surprisingly, as most people leave the building between 5pm and 6pm). There is a trend for increased activity as the week goes on, but there are no significant differences between days. Most of the activity

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[3] Unforeseeable technical problems (e.g. loss of internet connectivity, power outages) meant that on occasion not all of the three Plasma Posters were available.

peaks were generated by interactions at the kitchen Plasma Poster. Again, this was in accord with our interview and survey findings. Few people reported reading content on the foyer poster or the hallway Plasma Poster. When asked why not, people said the foyer poster was "out of the way", and the hallway poster was "too close to people's offices", where "it feels odd to stand outside someone's office door and read stuff".

Kitchen	Active Reading	95.9	61.2%
	Navigating	58.9	37.5%
	Messaging	2.0	1.3%
	Totals	156.8	
Hallway			
	Active Reading	34.3	75.1%
	Navigating	10.7	23.5%
	Messaging	0.6	1.4%
	Totals	45.7	
Foyer	Active Reading	18.7	66.0%
	Navigating	9.1	31.9%
	Messaging	0.6	2.1%
	Totals	28.4	
All	Active Reading	149.0	64.5%
	Navigating	78.7	34.1%
	Messaging	3.3	1.4%
	Totals	230.9	

Table 1: mean and percentage interactions per day

The category that is not reflected in our activity logs is *peripheral noticing*, as no touch interaction occurs when people are not (inter)actively reading, messaging or browsing. Observational studies are currently being carried out to measure the extent of peripheral noticing and distant reading (e.g., analyzing basic motion near a poster along with the interaction events), by content and poster location. Initial results show the kitchen area is the most traveled and populated of the three areas. It is also where people tend to "hang out". Current affairs articles, technology news items, images and movies draw most attention. Popularity of content is also related to sender; content posted by regular posters of "quirky content" and by absent colleagues is very popular. While people glance at all the Plasma Posters, only glances at the kitchen Plasma Poster regularly lead to touch screen interactions.

Perceived impact

Reactions to the Plasma Posters have been largely positive. All survey respondents said they had read items posted to the Plasma Poster, and 19 of the 23 said they had conversed with people about posted content. Many said conversations occurred when they were with others in front of the Plasma Posters, but 13 said they also conversed with others later about content they had seen on the displays. One respondent said "I often talk about stuff I see on the Plasma Posters, more usually with friends outside of work in fact". Two people said they had posted content to the Plasma Poster Network as part of an ongoing discussion. Although we cannot measure whether the Plasma Posters have increased informal interactions in the lab, we took reportage of these "conversational threads" as support for our assertion that the Plasma Posters spark conversations.

People commented that they liked finding out about others' interests. As one person phrased it, "I like seeing other people's interests and foibles, plus there is often quite a lot of interesting and relevant information in there". Another said, "I like coming across things I would not see otherwise". People also liked getting postings

from absent and remote colleagues ("it is nice to find out what they are thinking about or doing"; "it is great to see their face on the display").

Survey respondents were asked to comment on whether they saw value in having the Plasma Posters and if they would miss them were they to be taken away. All but three of our 23 survey respondents saw value in having the Plasma Posters, and were in favor of retaining them. Comments included: "I would especially miss the pictures posted by people who are away and I like seeing pictures of things people have attended, like conferences"; "I would miss having topics to talk about when it goes quiet at lunchtimes"; "I would miss interacting with people on topics posted on the poster"; and finally, "I would miss tidbits and insights into people's personalities and what interests them". By contrast, one person (a non-poster) said they would not miss the Plasma Posters because they felt the posters actually *detracted* from spontaneous conversational topics arising over coffee breaks and lunch because conversational topics naturally drifted to what was being shown on the Plasma Posters.

The Plasma Posters were not valued equally. While 20 of our survey respondents stated they would miss the kitchen Plasma Poster, only 4 said they would miss the hallway Plasma Poster. Three people said they would miss the foyer Plasma Poster, and 3 others said they thought it is good for visitors. It has taken time for the technology to be accepted, and for people to want to use it. One regular poster said although they had been unsure what to post at first, once they had started doing so "it was addictive".

Discussion

The Plasma Poster Network is actively used, and has had an impact on the social communication patterns within our organization. Members of our community post a wide variety of multi-media content, and are active readers who follow links and scroll through postings. Even infrequently used features (e.g. forwarding content, printing, messaging and replying to content authors) are highly valued.

To complement the design guidelines and the usage data presented above, we would like to spell out some of the *ergonomic* (physical, behavioral and cognitive ergonomic factors), *technical* (both the prototype requirements and the supporting technical infrastructure of the deployment location) and *social factors* (knowledge, expertise, relationship dynamics, broader organizational/civic/cultural context) that have arisen within this deployment.

In terms of the ergonomic issues explored for the current deployment, we have made efforts to ensure the Plasma Posters are *effective* interactive, public displays for their current placement. We have addressed issues of screen height, lighting and glare, font and button size, and color saturation on the display. Sensitivity to visual pollution has been essential; certain animations and dynamic screen changes have proven disturbing to some viewers. Sound pollution has also been addressed; initially all Plasma Posters had speakers, but these have been inactivated at the request of our

users. Interface design has proceeded with consideration of how to effectively signal functionality and invite interaction, without implying features that are not supported. Given we have a highly technical community, it has been a challenge to restrict interaction to our design intent without incurring frustration; on occasions members of our user community have wanted to appropriate the plasma displays as collaborative, digital workspaces, or as large screen interfaces to personal computers. On the other hand, as is always the case in design, there are tradeoffs; just as these behaviors derive from their comfort with technologies, their expertise has also meant they are tolerant of prototype failures, vocal with feedback and helpful with debugging.

While the above considerations pertain to the design of interfaces, or the "public face" or "skin" of the technology, it is also clear that the physical and technical infrastructure of our working environment has been crucial to the success of the technology. Without the ability to easily access power sockets, utilize existing mail servers, take benefit from our high-speed intranet and so on, the deployment would not have been possible.

Deploying within our organizational setting has meant maintaining a sense of corporate professionalism that may not be so important in other settings. However, the restricted physical setting combined with the relative social informality of our workplace has been beneficial. For example, we have a minimal content moderation policy, relying on social accountability and a shared sense of content appropriateness[4]. Other locales will undoubtedly require more active content moderation. Having said that, our workplace has permeable boundaries, socially speaking; on several occasions (3), we have been asked to remove company sensitive material to avoid exposure to visitors. Judging content appropriateness becomes more problematic as we make it easy for people to post content into places they have never visited; even with the best of intentions, it is easy for people to *inadvertently* post socially inappropriate material.

Summary and Future Work

In this paper we have described the design and deployment of three digital, community bulletin boards, the Plasma Posters, within our lab. The Plasma Posters have become an everyday part of our environment, and are seen as a valuable addition to the physical environment and a complement to other content sharing methods. The Plasma Posters have increased social interaction between members of the lab. Content that in the past has been shared within small groups has been posted to the Plasma Posters resulting in the discovery of overlapping interests across groups. Interview data indicate some posted content may not have been previously shared *at all*, implying we have created a new genre of communication within our lab (see Yates and Orlikowski, 1992). These observations lend support to our belief that such technologies have a role to play in forging new ties and reinforcing existing ones

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[4] Interestingly, however, when inappropriate content was posted and displayed on one occasion, it was perceived to be a *technology* problem and not a *social* problem.

(Granovetter, 1983). In this regard, their success stands in contrast to the infrequently used, non-digital, community poster boards, and seems to derive specifically from their networked, dynamic, interactive nature, and is, of course, related to the good fit with existing content sharing (and general work) practices.

The design of the Plasma Poster Network has involved careful consideration of *ergonomic factors*, *technical factors*, and *social factors*. As we prepare for deployment of this technology in an external site, we are using checklists derived from our design guidelines and observations.

In conclusion, we are encouraged by our initial explorations within this area with the design, development and deployment of the Plasma Poster Network. We believe such community technologies represent a new genre of community communication. They combine practices of online digital content sharing within social networks with public display technologies that, to date, have been more associated with broadcast, corporate content. Explorations within this design area are revealing ways in which the digitally enhanced, physical environment can be used as a canvas for asynchronous communication, blurring the boundaries between online community participation and offline interactions. There are many fascinating socio-technical design challenges to be faced.

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Knowledge Sharing in Knowledge Communities

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Abstract. This paper investigates the contribution of ICT to knowledge sharing in communities of practice. A theoretical model is built that identifies the possible influence of ICT on the extent to which knowledge is shared within a community, as well as a number of variables that determine the extent to which this contribution is realized. This theoretical model was tested within two ICT-facilitated communities for professionals in the area of working conditions. The results of these case studies show that ICT's most important contribution to knowledge sharing in communities consists of the realization of a shared information base (communality) and facilitating communication independent of time and place (connectivity). The results also show that trust among members of a community, and their identification with the community, are important influences on knowledge sharing. Task interdependence and the community's information culture are also identified as important influences.

Introduction

In theory and research concerning knowledge management and knowledge sharing, increasing attention is being paid to a 'community-based' approach (Scarbrough & Swan, 2001), in which shared practices among members of such a

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community are the basis for knowledge sharing, and not their formal organizational roles. As Brown & Duguid (2001) argue, shared practices are the basis for a "common know-how". This common know-how is a common frame of reference, which explains why knowledge can flow relatively easily among members of a community that is based on shared practices. As Scarbrough and Swan (2001) put it: "(...) knowledge-sharing is facilitated by the norms of reciprocity, and the levels of trust generated among the community" (p. 12). Communities are especially identified as effective environments for the sharing of implicit knowledge (Brown & Duguid, 1991; 2001; Davenport & Prusak, 1998; Huysman & Van Baalen, 2001; Wenger, 1998).

In today's knowledge-intensive economy, such knowledge (both implicit and explicit) is becoming an increasingly important resource. The sharing of knowledge between individuals with similar or dissimilar practices, in and between organizations is considered to be a crucial process (O'Dell & Grayson, 1998; Osterloh & Frey, 2000). The role of technology, especially of information and communication technology (ICT) in supporting such processes is the subject of many debates (Roberts, 2000; Huysman & De Wit, 2002; Huysman & Van Baalen, 2001; Scarbrough & Swan, 2001; Zack, 1999). Communities are often defined in ICT terms – as "virtual communities" or "virtual teams". ICT is often seen as a valuable means in bridging gaps of space and time between members of such communities, who often originate from different organizations and different locations. On the other hand, the risk of automatically defining communities in such terms creates the risk of an 'ICT pitfall' (Huysman & De Wit, 2002; Weggeman, 2000): too strong a focus on the technology could lead to neglecting the organizational, social and psychological elements of communities and knowledge sharing. For an accurate view of what the added value of ICT can be for knowledge sharing in communities, it is important to consider the role of ICT together with other influences, such as identification and trust within communities (Roberts, 2000; Scarbrough & Swan, 2001).

In this paper, we focus on this contribution that ICT can make to knowledge sharing in communities. Knowing that the use and effects of ICT in such processes is itself part of a broader range of influences on knowledge sharing, the question that is central to this paper is:

What is the contribution of ICT to knowledge sharing within communities, and which factors determine the extent to which this contribution is realized?

In order to answer this question, we first discuss relevant theories concerning this subject, which lead to an integrated theoretical model of the contribution of ICT to knowledge sharing. This model was tested in two case studies, which were conducted within two knowledge communities for professionals in the area of working conditions. Based on these case studies, we present an empirical model in

which the contribution of ICT to knowledge sharing within communities, and the factors determining this contribution, are summarized.

Theory: knowledge sharing and ICT

Factors affecting knowledge sharing

Knowledge sharing is the process where individuals mutually exchange their (implicit and explicit) knowledge and jointly create new knowledge. The extent to which this process actually takes place is influenced by a number of factors, which Hinds & Pfeffer (2003) label *cognitive* and *motivational* limitations towards knowledge sharing. Cognitive limitations are related to the way that experts store and process information. As level of expertise increases, the level of abstraction in representing that expertise increases as well. In other words, it is often hard for experts to put their knowledge into words that are understandable to non-experts. They overestimate non-experts' information processing capability and basic knowledge level, and underestimate the time non-experts need to complete and understand certain tasks.

Where cognitive limitations are related to an individual's *ability* to share knowledge, motivational limitations are related to their *willingness* to share knowledge. Different incentives and disincentives for this willingness are distinguished by Hinds & Pfeffer, such as team level rewards, internal competition, status differences, degree of formalization and the individual's relationship to the organization.

With regard to this latter influence on people's willingness to share, Hinds & Pfeffer point towards trust as an important variable. The extent to which coworkers are trusted to reciprocate favors (i.e., provide their knowledge in return) and the organization is trusted not to use provided knowledge against an individual, determines this individual's willingness to actively share knowledge with others inside this organization. Orlikowski (1993) for instance, describes how in a very competitive environment, distrust in others inhibited the sharing of information. Pan and Scarbrough (1998) observe how a "climate of continuity and trust" is a crucial (and hard to realize) condition for knowledge sharing. Roberts (2000), in an investigation of how ICT contributes to knowledge sharing, points out the importance of trust – especially as a prerequisite for the transfer of implicit knowledge.

Another influence on the willingness to share identified by Hinds and Pfeffer is the extent to which individuals identify with the team or group of which they are a part. The stronger they identify with this group, the more they will be willing to share knowledge within this group. Stronger identification with the group may, however, also lead to a reduced willingness to share knowledge outside of the

group. Social identification is an important condition for cooperation (Wiesenfeld, Raghuram & Garud, 1999), and may lead to a more collectivistic climate within a group, which in turn promotes cooperation (Wagner, 1995), leads to more effective knowledge processes (Gladstein, 1984), more communication in the group (Moorman & Blakely, 1995) and better group performance (Eby & Dobbins, 1997).

So, both the ability to share knowledge and the willingness to share knowledge are identified as important influences on knowledge sharing. Mutual trust and identification with the community are identified as important characteristics of community members influencing knowledge sharing. In conclusion, this discussion leads to the following hypotheses:

H1. An individual's ability to share knowledge positively influences the extent to which they actually share knowledge.

H2. An individual's willingness to share knowledge positively influences the extent to which they actually share knowledge.

H3. The extent to which an individual trusts the other members of a community positively influences their willingness to share knowledge within that community.

H4. The extent to which an individual identifies with the other members of a community positively influences their willingness to share knowledge within that community.

ICT and knowledge sharing

By sharing their knowledge, members of a community contribute to the shared intellectual capital of the community – which can be conceived as a "public" or "collective" good (Nahapiet & Ghoshal, 1998), since it possesses two key characteristics of such goods (Monge et al, 1998): (1) *Impossibility of exclusion*: members of the collective (i.e., the community) can not be excluded from using the good even if they do not contribute to it; and (2) *Jointness of supply*: one person's use of the good does not diminish the level of good for other users. The value of the shared intellectual capital is not influenced by the fact that other members of the community use it.

For such a public good to be realized, a sufficient number of members of a community must contribute to the shared intellectual capital (i.e., share their knowledge). According to Fulk et al (1996), ICT contributes to such collective action through the realization of two public goods:

1. *Communality*, the collective storing and sharing of information to which all members of the collective have access, and.
2. *Connectivity*, the ability to reach other members of the collective.

Connectivity is the ability for members of a social system to contact each other directly. Easy and frequent contact with other members of a community can be considered to be an important contribution of ICT to knowledge sharing: connectivity positively influences both the ability and the willingness of members of a community to share knowledge. Communality, on the other hand, exists where organizational members have access to a commonly held body of information. This is also expected to be positively related to knowledge sharing: the more the shared intellectual capital is accessible to members of a community, the more these will be willing to contribute their own knowledge to it. Since accessing the shared intellectual capital will also increase one's awareness of others' capabilities and interests, communality can also be expected to positively influence the ability to share knowledge. This leads to the following hypotheses:

H5. The use of ICT within a community leads to a shared information base (communality) within that community.

H6. The use of ICT within a community leads to more contact (connectivity) among members of that community.

H7. Communality positively influences both (a) the ability to share knowledge and (b) the willingness to share knowledge.

H8. Connectivity positively influences both (a) the ability to share knowledge and (b) the willingness to share knowledge.

With regard to the influence of ICT use on identification with the community, the lack of 'social cues' (such as tone of voice, facial expressions, gestures and the like) in communication via ICT is often expected to negatively influence the social richness of this communication (Short, Williams & Christie, 1976; Daft & Lengel, 1984; 1986; Trevino, Daft & Lengel, 1990). Thus, the lack of social cues could be expected to lead to less identification with those with whom communication takes place than in a face-to-face setting.

Empirical results, however, contradict this (Walther, 1992; Walther & Burgoon, 1992; Postmes, Spears & Lea, 1998). In a search to explain such results, Walther (1996) argues that computer-mediated communication can lead to *hyperpersonal* interactions – indeed, communication with a richer level of social relationships than found in face-to-face conditions. His conclusion is that specific characteristics of ICT (such as reduced social cues and asynchronous communication) can even lead to socially 'richer' communication, to stronger identification with the group and thus to more collective behavior.

A related perspective is the Social Identification model of Deindividation Effects, also known as the SIDE model (Reicher, Spears & Postmes, 1995; Spears & Lea, 1992). SIDE proposes that social cues can facilitate the individuation of communication partners – in other words, forming impressions of them as idiosyncratic individuals. In computer-mediated conditions, where social cues are relatively scarce, *group* characteristics are likely to be attributed to individuals –

i.e., their *social identity* is likely to become more salient than their individual identity. Thus, provided that the relevant social group and its attributes are known, the lack of social cues in ICT can "accentuate the unity of the group and cause persons to be perceived as group members rather than as idiosyncratic individuals" (Tanis & Postmes, in press: 8). So, SIDE theory argues the use of ICT positively influences identification with a community. Since the shared practice of a community is in itself a ground for identification (Brown & Duguid, 2001; Scarbrough & Swan, 2001) and forms a typical "common identity" with which members can identify (Postmes & Spears, 2000), we expect a positive contribution of ICT to identification with the community:

H9. The use of ICT within a community positively influences the identification of community members with that community.

The use of ICT in a community also has consequences for the degree of trust among the members of such a community. The 'traditional view' here is that communication that is mediated by ICT is insufficiently rich or social to establish real trust. Handy (1995) argues that without face-to-face interactions, trust cannot emerge. Nohria and Eccles (1992) consider face-to-face interactions to be crucial to both building and maintaining trust. As Roberts (2000) argues, trust is more complex than mere communication, and requires a common social and cultural framework. For this to emerge, Roberts argues, face-to-face communication is crucial – as Handy (1995: 46) puts it: "trust needs touch".

A number of studies produce a somewhat different view of the influence of ICT on trust in groups. As Jarvenpaa and Leidner (1999) argue, virtual teams that exclusively interact through ICT can very well develop trust, albeit a task-related, "swift" kind of trust instead of truly interpersonal or socially based trust. Bos et al. (2002) compared four modes of communication and found that face-to-face was indeed the mode of communication that generated the most trust among communication participants, closely followed by video and audio conferencing. Purely text-based communication (chat) generated significantly less trust. Burgoon et al. (2003) found that participants who communicated exclusively through ICT were able to establish trust and mutuality without meeting face-to-face. Boisot (1998) claims that electronic communication enables co-presence without co-location, which would enable a person to build "a more "trusting" relationship with a transaction partner located on a neighboring continent than with one located in a neighboring room" (p. 225).

Shared practice is not only a ground for identification (as mentioned before), but also one for trust. Or, as Brown (n.d.) puts it on the "Storytelling" website:

"(...) when you share a practice, when you have evolved a practice together in a community of practice, you have learnt to read each other, and basically because of that shared practice, there

is a kind of trust that is built up, such that basically knowledge circulates amazingly well within a community of practice."

Our position here is that ICT helps members of a community to overcome barriers of space and time, and thus to communicate more efficiently and intensively with each other than when they had to meet in person all the time – enabling them to further evolve this trust.

H10. The use of ICT within a community positively influences the degree of trust among members of a community.

Factors affecting the use of ICT for knowledge sharing

Jarvenpaa and Staples (2000) provide insight into the factors which influence individual's choices for ICT's to support knowledge sharing. First of all, on an individual level they identify *task interdependence* as a relevant factor here: individuals whose work is interdependent of others will be motivated to use such collaborative technologies more. Another influence on the individual level is related to individuals' attitudes towards the technology: *computer comfort.* Following Davis' (1989) Technology Acceptance Model, such an attitude can be expected to have a significant influence on an individual's choice whether to use ICT for knowledge sharing. A related attitude concerns the *content* found in ICT: an individual's *attitude towards computer-based information* (specifically concerning quality and accessibility) is also expected to determine their use of such technologies.

Another influence identified by Jarvenpaa and Staples concerns the organizational (or, in this case, community) level. The *information culture* in such an organization (or community) is expected to be of influence on ICT use: following Davenport (1997), it is expected that an open and organic information culture within such a community positively influences the use of ICT in that community. Such a culture is characterized by open exchanges, an external orientation and focused on empowerment of individuals. Jarvenpaa and Staples also mention *propensity to share* and *ownership of information* as influences on the use of ICT for knowledge sharing, but such variables have already been integrated in our discussion on motivational factors – or willingness to share.

All in all, the following hypotheses concerning influences on ICT use for knowledge sharing in communities are derived from this:

H11. Task interdependence positively influences the extent to which a member of a community uses ICT to share knowledge with other members.

H12. Computer comfort positively influences the extent to which a member of a community uses ICT to share knowledge with other members.

H13. A positive attitude towards computer-based information positively influences the extent to which a member of a community uses ICT to share knowledge with other members.

H14. An open and organic information culture within a community positively influences the extent to which members of that community use ICT to share knowledge among each other.

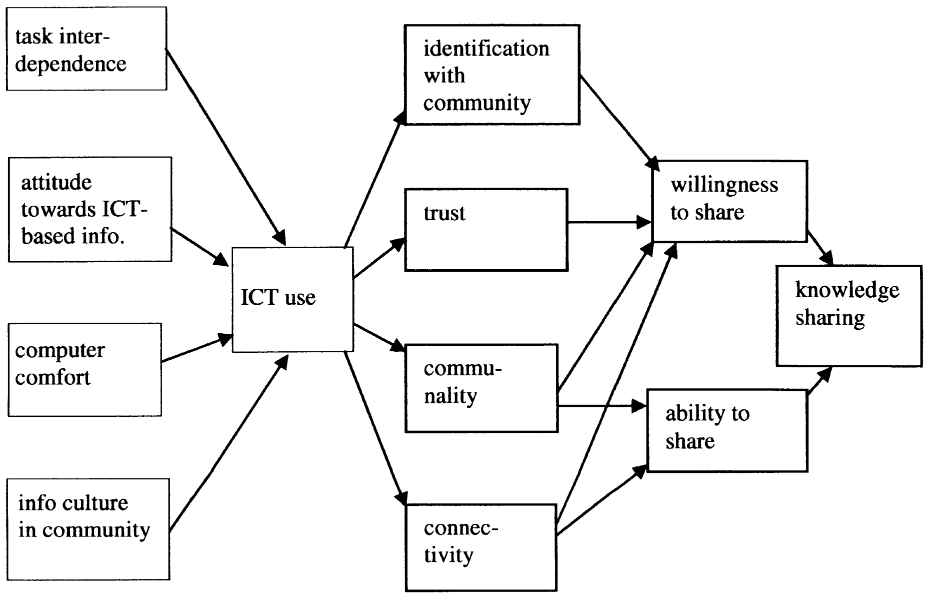


Figure 1: Theoretical model

Theoretical model

So, the theoretical discussion in this section has yielded 14 hypotheses concerning the contribution of ICT to knowledge sharing in communities, and the conditions under which this contribution can be realized. In figure 1, these hypotheses are represented in an integral theoretical model that forms the basis for the case studies discussed in the following sections.

Study sites and methods

The theoretical model presented in the previous section was tested in two case studies. Both case studies consisted of ICT-facilitated professional communities of practice concerning working conditions. Both communities were aimed at professionals in the area of working conditions – advisors, consultants, doctors, etcetera – and were facilitated by the Dutch research and consultancy organization TNO Work and Employment.

The first community is called "Arboconet" and is a community in which professionals from different branches of trade gather to exchange information. This community has its origins in a couple of face-to-face meetings organized by TNO Work and Employment. The ICT environment studied here was designed on the basis of the members' request to enable them to exchange information in other ways than only face-to-face.

The second community is "Arbozw" and is originally a "knowledge center" established by a branch organization for health care and welfare. It is primarily oriented towards professionals in the health care sector. Contrary to Arboconet, its origins are not in face-to-face meetings, but in the ICT environment that was explicitly established to facilitate the sharing of knowledge among such professionals.

Both ICT environments have comparable functionalities, which can be separated into functionalities for storage and retrieval of (static) information and functionalities for the exchange of information (dynamic). For instance, storage and retrieval functionalities are: news pages, journal articles, a calendar with relevant events, legislation, best practices, links to libraries and databases and frequently asked questions. Exchange functionalities found in both environments are discussion fora and discussion archives, opinion polls and various possibilities to react to others' contributions.

In both communities, members were approached with the request to fill in a questionnaire with some 80 statements. The questionnaire was administered both electronically (through the ICT environments) and on paper. A total of 257 questionnaires were returned: 107 from Arbozw (about 20% response) and 150 from Arboconet (about 15% response).

The relevant variables from the hypotheses were measured using a number of different scales. The scales used for knowledge sharing and the factors influencing knowledge sharing are presented in table 1.

scale items	M	SD	alpha
knowledge sharing	20.99	4.65	.87
whenever I've learned something new, I tell the other members of this community about it I tell the other members of this community what I know, when they ask me about it I tell the other members of this community about my skills, when they ask me about it When they've learned something new, other members of this community tell me about it I ask other members of this community what they know when I need particular knowledge the other members of this community tell me what they know, when I ask them about it the other members of this community tell me about their skills, when I ask them about it			
willingness to share	16.14	2.11	.64
I'm afraid to lose influence when sharing knowledge (recoded) I keep important matters to myself (recoded) I think I function better when I share what I know I think it's important that professionals are interested in each other's knowledge			
ability to share	10.51	2.55	.65
I find it hard to put what I know into words I find it hard to understand others' knowledge on working conditions I am unable to share my knowledge It is often impossible for my to make my knowledge on working conditions concrete for others			
identification with community	12.30	3.02	.66
I feel a bond with the other members of this community I feel solidarity with the other members of this community I identify myself with the other members of this community I really feel I'm part of the group within this community			
trust	20.00	13.07	.76
other members of this community help me when I have a problem concerning working conditions I can rely on the other members of this community to support me in my work I can count on the other members of this community to do what they say I have faith in the skills of the other members of this community			

Table 1: Scales and items: knowledge sharing and factors

All items in these scales used five point Likert scales as answering categories. The means have been computed on the basis of the sum total of these scores. The scales for knowledge sharing, ability and willingness to share have been used in previous research (Van den Hooff, Vijvers & De Ridder, 2003; Van den Hooff & De Ridder, 2003). The scale for identification is derived from Doosje, Ellemers

and Spears (1995), and the items measuring trust are based on Wrightsman (1999).

scale items	M	SD	alpha
task interdependence	8,87	2,41	.72
in my work, I often cooperate with people from other organizations my work requires me to share information with people from other organizations the results of my work are dependent of people in other organizations			
computer (dis)comfort	14,17	2,45	.82
I am uncertain using computers, since I might make incorrectable errors I fear that using a computer I will lose information by pressing a wrong button computers make work more interesting (recoded) I am uncomfortable using a computer working with computers is fun (recoded)			
attitude towards computer based information	21,07	3,73	.95
thanks to ICT, I can find more up to date information ICT provides better access to new information ICT saves time when searching for information ICT makes it easier to obtain certain information ICT makes new information available for my organization			
information culture in community	13,57	2,05	.77
organization is open or closed with regard to new information facts or rumors and intuition primary source of information mutual trust or distrust towards sharing information			
communality	12,33	2,89	.78
this community helps me obtain relevant information on working conditions faster I help other members of this community to obtain information that is useful to them I contribute actively to the information available within this community within this community, we work together towards creating a shared information base			
connectivity	13,51	3,28	.91
thanks to this community, I can communicate faster with other professionals in this area through this site, I can exchange information with people from outside my organization faster through this site, it has become easier to come into contact with other members of this comm. I use this site to overcome distances between me and other professionals in this area			

Table 2: Scales and items: ICT use and factors

The scales for ICT use and the factors influencing this ICT use are presented in table 2. The scales for ICT use are based on the functionalities found in both ICT

environments, and factor analyses showed that separate scales should be constructed for the storage and retrieval functionalities (Cronbach's alpha = .83) on the one hand, and the exchange functionalities on the other (Cronbach's alpha = .85). The scales for task interdependence, computer comfort, attitude towards computer-based information and information culture were derived from Jarvenpaa & Staples (2000). The scales for communality and connectivity were constructed specifically for this study. Again, all items were scored on five point Likert scales, except the ones measuring information culture, which were scored on a seven point scale.

As the statistics in tables 1 and 2 show, all scales used in this study were homogeneous with Cronbach's alphas exceeding .60. Factor analyses showed that all scales were unidimensional as well, except for the one measuring ICT use, which was divided into storage & retrieval and exchange.

Results

The data from both cases were integrated into one dataset that provided the basis for the empirical testing of the theoretical model. A first test of the hypotheses in the theoretical model in figure 1 was conducted by performing linear regression analyses (stepwise) for each of the dependent variables in the theoretical model. In these analyses, the distinction between ICT use for storage and retrieval on the one hand, and for information exchange on the other, was incorporated. The results of these analyses are summarized in figure 2. For each of the dependent variables, the proportion of variance explained (R2) is given above the variable in question. So we can conclude, for instance, that 53% of the variance in knowledge sharing is explained by identification, trust, communality and connectivity. The figures near the arrows are the betas for each of the relationships found.

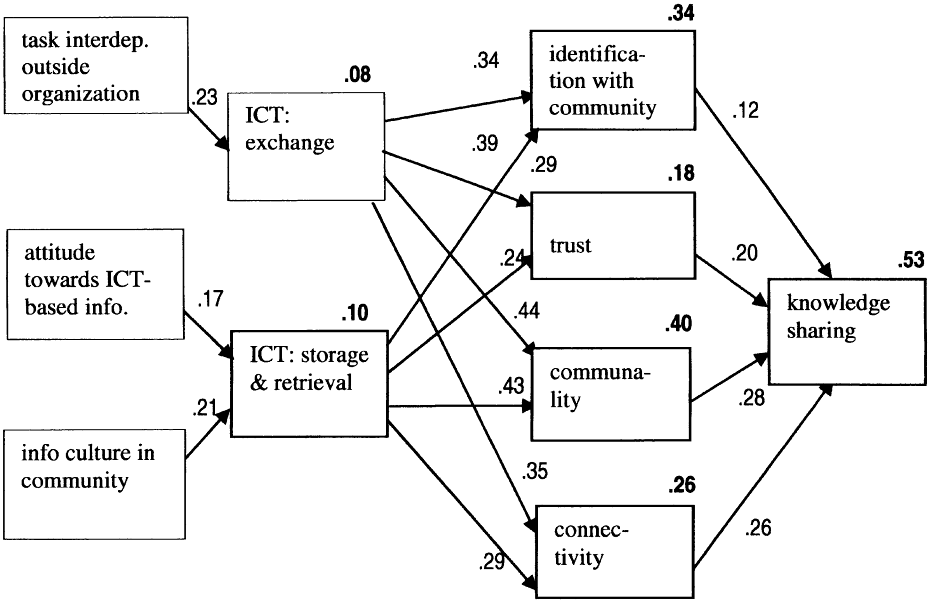


Figure 2: Regression model

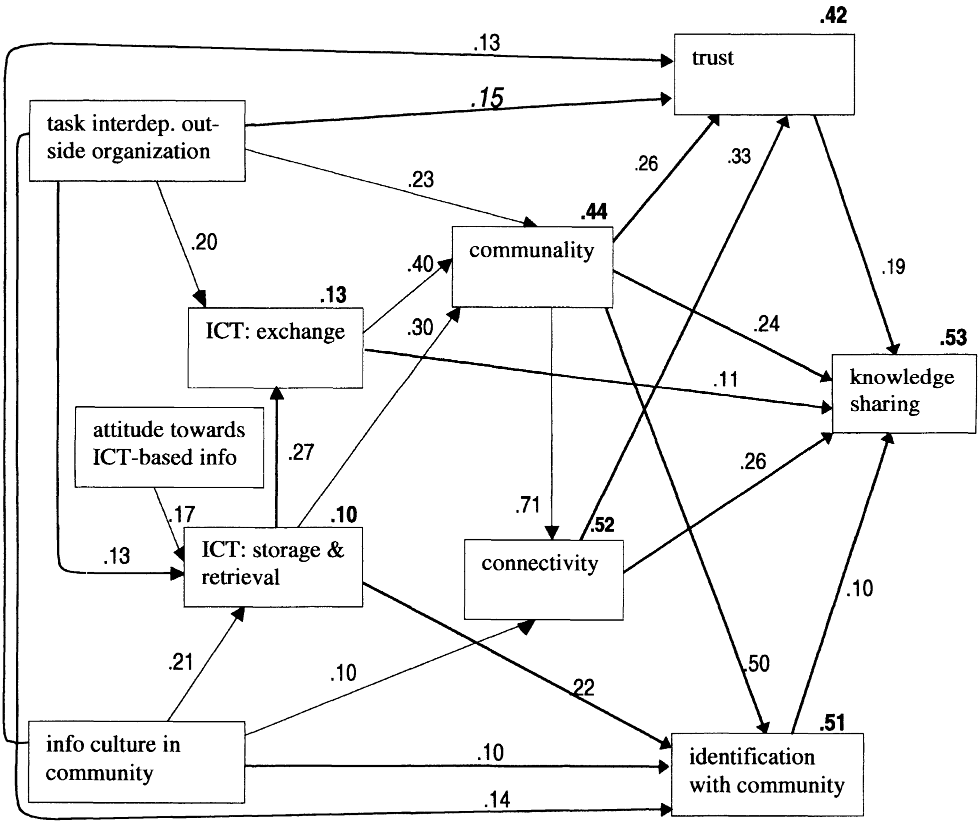
Although this model is at a number of points quite similar to the theoretical model in figure 1, there is one remarkable difference: willingness and ability to share were not found to predict knowledge sharing behavior – knowledge sharing is directly influenced by identification, trust, communality and connectivity, and not mediated by ability and willingness to share. This is in partial contradiction to hypotheses H1 through H4 as well as H7 and H8. Still, the assumption that identification, trust, communality and connectivity are positive influences on knowledge sharing is supported by these results. These influences are not mediated by willingness and ability to share, however.

Hypotheses H5 and H6 receive support from these analyses, as well as H9 and H10: the use of ICT positively influences the creation of communality and connectivity, as well as identification and trust within the community. This holds for both dimensions of ICT use: storage & retrieval as well as exchange.

As for H11 through H14, only H12 is rejected on the basis of these results: computer comfort was not found to be a predictor for ICT use. Here, the distinction between both dimensions of ICT use is important: task interdependence is found to positively influence the use of exchange functionalities (providing support for H11), where attitude towards information in computers and an open and organic information culture in the community are found to positively influence the use of storage and retrieval functionalities. This latter result provides support for hypotheses H13 and H14.

All in all, the analyses provide considerable support for the theoretical framework presented before. The representation of the results in figure 2 is,

however, not entirely methodologically sound – the model as a whole was not tested, just the various relationships of which it consists. In order to get a more complete insight into the model and relationships, a structural equation model analysis was performed using AMOS (Arbuckle & Wothke, 1999), a software package which supports data analysis techniques known as structural modeling, analysis of covariance structures, or causal modeling. Structural equation modeling basically enables the testing of a set of regression equations simultaneously, providing both parameter statistics for each equation and indices which indicate the "fit" of the model to the original data. Based on the data discussed in the previous sections, the structural equation model that optimally fits these data and has the strongest explanatory power is the one presented in figure 3.



(chi square = 28.0 (df = 19). p = .084. TLI = .997. RMSEA = .04)

Figure 3: Structural equation model

In the model in figure 3, seven endogenous (or 'downstream') variables are distinguished. Also, three exogenous (or 'upstream') variables are defined. The standardized regression coefficient for each relationship is indicated by the number near the arrow symbolizing the relationship. For each endogenous variable, the proportion of variance explained by these regression equations (R square) is indicated as well.

For the model as a whole, three statistics are found to be relevant. Although AMOS produces a very large number of different statistics, the University of Texas (n.d.) mentions that these three statistics are the commonly reported fit statistics:

1. The chi square value. This value indicates the absolute fit of the model to the data, and is the result of the testing of the null hypothesis that the model does indeed fit the data. For the model in figure 3, the chi-square test of overall model fit is 27.996 with 19 degrees of freedom, returning a probability value of .084 that a chi-square value this large would be obtained by chance if the null hypothesis that the model fits the data is true. In other words, this statistic indicates that the model fits the data.
2. Tucker-Lewis Index (TLI): The Tucker-Lewis Index (TLI) is an example of a relative fit statistic (not sensitive to sample size and non-normality), and compares the absolute fit of the specified model to the absolute fit of the most restrictive model possible, in which all relationships between the observed variables are assumed to be zero. The greater the discrepancy between the overall fit of the two models, the larger the values of these descriptive statistics. TLI values close to 1 indicate a very good fit (Arbuckle & Wothke, 1999), and for the model in figure 3, this value is .997. So, this is further evidence for a good fit of this model to the data.
3. RMSEA: the Root Mean Square Error of Approximation, based on a comparison of the values in the specified model to population means and covariance structures. There are several rules of thumb concerning this statistic, such as the one by Browne and Cudeck who claim that an RMSEA of .05 or less would indicate a close fit of the model in relation to the degrees of freedom (Arbuckle & Wothke, 1999). Since the model in figure 3 has an RMSEA of .048, this statistic provides further evidence of a good fit of the model.

On the basis of both regression coefficients and fit indices, a number of conclusions can be drawn from this model with regard to the contribution of ICT to knowledge sharing. First of all, the model confirms that willingness and ability to share are not, contrary to what we expected, predictors of knowledge sharing. The model also confirms the importance of trust, identification, communality and connectivity in explaining knowledge sharing in communities, and it shows that

the relationships are somewhat more complex than the model in figure 2 would indicate.

Communality appears to be an important effect of ICT use. A shared information base forms the basis for a community: it positively influences both trust and identification in the community. Communality is also found to directly influence knowledge sharing in a community. Finally, it also positively influences connectivity: apparently, the existence of a shared information base facilitates contacting other members of the community. Such an information base can be seen as an important part of a communities common knowledge, its common frame of reference even. Such a common base also provides an individual member of the community with information on who the other members are, what they do and what they know – which can indeed be an important facilitator of contacting the "right" people.

Connectivity, in turn, primarily facilitates knowledge sharing. Once it is easier to contact the other members of the community, more knowledge is also shared with these other members. The fact that ICT enhances the ability of community members to come into contact with other members also positively influences trust among these members. This confirms our theoretical argument that ICT's contribution to such trust lies in facilitating easier and more frequent contact (independent of time and place) among members of a community.

The contribution of ICT to knowledge sharing, this model shows, further lies in creating communality, which (as described before) can be seen as the basis for a community. The relationship between both dimensions of ICT use is comparable to the relationship between their effects: where communality creates the conditions for connectivity, the use of ICT for storage and retrieval promotes the use of ICT for exchanging information. The contribution of ICT is also found in directly facilitating knowledge sharing (through exchange functionalities) and in enhancing identification (through storage and retrieval – that common frame of reference again).

Finally, the factors hypothesized to influence ICT use, are found to influence more than that. An open and organic information culture not only explains ICT use, but also connectivity, trust and identification. Task interdependence on the other hand, not only explains ICT use, but also communality, trust and identification. So, such characteristics of communities and their members are important explanations for the degree of knowledge sharing that takes place within such communities.

On the whole, these results indicate that ICT can indeed have a positive contribution to knowledge sharing. As mentioned in the theoretical section, face-to-face interaction is often considered to be an important addition here – members of communities who also interact face-to-face are likely to develop higher levels of trust, identification and (consequently) share more knowledge than those who don't. Since both communities studied here have quite different origins

(Arboconet originated from face-to-face interactions, whereas Arbozw did not), it is interesting to see to what degree they score differently on a number of key variables. A t-test was performed for this purpose, and the results of this analysis are presented in table 3.

	M		T-value	P
	arboconet	arbozw		
knowledge sharing	20.2	22.1	-3.1	.001
willingness to share	16.1	16.2	-0.7	.502
ability to share	10.9	10.1	2.7	.008
trust	12.6	13.6	-3.7	.000
identification	11.8	13.0	-3.3	.001
ICT use (storage & retrieval)	10.0	10.9	-2.3	.025
ICT use (exchange)	4.1	8.0	-9.4	.000

Table 3: Means and differences for both communities

Contrary to our expectations, Arboconet (with a face-to-face origin) did *not* score higher on trust, identification and knowledge sharing. Surprisingly, Arbozw (with an ICT origin) scored significantly higher on each of these variables. The only variable where Arboconet *did* score higher was the ability to share knowledge. Apparently, the fact that the members of this community already knew each other from face-to-face meetings makes it easier for them to estimate others' levels of knowledge and to put their knowledge into words that are understandable to these others. For all the other variables, however, we see that either there is no difference (willingness to share), or that Arbozw scores higher.

Conclusion

The conclusion we can draw from the findings presented before is that ICT can indeed have a positive contribution to knowledge sharing in communities, but that this contribution is part of a complex set of influences and relationships. The use of ICT by community members directly facilitates easier exchanges (independent of time and place) between them, and it helps create two public goods (communality and connectivity) that further promote knowledge sharing. ICT use also plays a role because it influences mutual trust and identification between community members.

So, ICT plays a role (and a not unimportant one when we look at the strengths of the relationships found), but this influence should be considered in interaction with a range of other factors. Not only trust and identification between community members are important here, but also an open and organic information culture, as well as the extent to which the tasks of community members are interrelated.

Discussion

The results of our case studies provide support for the theoretical arguments made before. An important conclusion is that communality is a central contribution of ICT to knowledge sharing in communities. Not only does a shared information base directly contribute to knowledge sharing, but it also positively influences trust and identification in the community. We would argue that this shared information base is the explicit manifestation of the shared practice that is so central to communities: this is where the common knowledge, experiences and frames of reference are found.

The fact that, primarily through this communality, ICT positively influences trust and identification, offers support for the theoretical arguments made with regard to those variables. The central premise of SIDE theory, that ICT use can enhance social identification is certainly not contradicted by these results. The arguments made with regard to trust also hold. The importance of being able to overcome barriers of time and space are crucial here – creating and maintaining trust may well be best served by intensive face-to-face communication, but the fact that ICT facilitates frequent communication between community members who are geographically dispersed may be more important than the relative "richness" of such media. So, the contribution of ICT here lies primarily in allowing community members to communicate frequently and intensively, irrespective of the time and place where they want to do so. For truly interpersonal trust (instead of "swift", task-related trust), it would however seem important to use ICT not as a total substitute for face-to-face communication, but as an addition to it.

It would seem that the comparison between the two communities would contradict this supposed importance of face-to-face interactions next to ICT interactions: the community originally based on face-to-face meetings scored lower on trust, identification and knowledge sharing than the one with an ICT origin. There are two alternative explanations for this, however. The first, and most important one, is that the healthcare community (Arbozw) has an explicit focus – all members work in the health care sector, and thus have a broad range of shared practices. For the other community, this is much less the case: although the members all have some sort of coordinating function regarding working conditions, the diversity in backgrounds is much larger. Members of this second community come from all kinds of different branches of trade, so there shared

practice is much more amorphous and diverse. This explanation further supports the importance of such shared practices. A second explanation is the fact that the ICT environment for the health care community has been existence longer than the other one – Arbozw is more than a year 'older' than Arboconet, so the experience that the members of the first community already have in communicating through ICT may also be an explanation for this finding.

On the whole, we can conclude that most variables distinguished in the theoretical section of this paper do indeed influence knowledge sharing in communities, but that the relationships are more complex than assumed at first. For instance, the factors assumed to influence ICT use are partly factors that do much more than that: task interdependence and information culture are important predictors of trust and identification within a community. The distinction between different dimensions of ICT use (storage & retrieval versus exchange) also proved to be an important addition.

With regard to future research, it would be interesting to further explore the main dependent variable in our research: knowledge sharing. In this study, we focused on the *extent* to which members of a community share knowledge. In the introduction of this paper, however, we mentioned that communities are specifically seen as environments for the sharing of *implicit* knowledge. It would therefore be very interesting to explore the *kind* of knowledge being shared in communities instead of only the *amount* of knowledge. Other dimensions of knowledge sharing should also be incorporated into such further qualifications of this concept: the relevance of the knowledge being shared, the breadth and depth of it, and the ease with which the process takes place.

The arguments made before also indicate that a more explicit comparison of knowledge sharing in communities in face-to-face and ICT conditions would be an interesting avenue of research. Both as additions and as substitutes, both modes of knowledge sharing should be explicitly linked to crucial variables such as identification, trust and knowledge sharing. It would also be useful to distinguish between different kinds of ICT applications – not only shared databases and electronic discussions, but also video or audio conferencing, CSCW et cetera.

The differences found between the two communities in terms of trust, identification and knowledge sharing also warrant some further study of the importance of time: a longitudinal study into how communities form and develop, and how knowledge sharing within such communities develops over time. Specific attention should also be paid to the different roles of face-to-face and ICT-based communication – is face-to-face communication primarily of interest in the phase where the community is created for instance, and is ICT communication more important as communities have existed for a longer duration? These differences, and the explanations given for them, also give a further indication (together with the results discussed before) that shared practices are a central subject of research when studying communities.

Finally, a number of practical implications come to the fore as well. First of all, when creating or maintaining a community of practice, it is important to establish trust and see to it that there is a common identity for members to adhere to. In line with this, the fact that members share a certain practice should also be emphasized. Finally, an optimal balance should be found between face-to-face communication on the one hand, and ICT on the other. As this study indicates, such actions would create favorable conditions for knowledge sharing within a community.

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Uses of information sources in an Internet-era firm: Online and offline

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Abstract. Most research on the role of information and communication technologies (ICT) in the workplace has focused on companies that adopted ICT after many years of working without it. However, companies that have been "always connected" may offer different lessons. In this study, we look at how workers at an Internet-era company obtain information they need to do their jobs. We look at both human and documentary sources of information; whether those sources are accessed online or offline; and the impact of type of information source and access on individual performance. Results parallel past research with two significant differences: 1) workers accessed human sources via online channels more frequently than via offline channels, and 2) higher individual performance was associated with online access to human sources rather than offline access to human sources. The findings have implications for theories of knowledge management and uses and effects of technology in organizations.

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Introduction

The challenges of implementing information and communication technologies (ICT) in organizations have been well documented in case studies across many industries (e.g., Leonard-Barton, 1988; Markus & Keil, 1994; Orlikowski, 1996). However, comparatively little research has been done on companies formed after widespread adoption of the Internet. For those companies, ICT has been part of the way they work from the very beginning.

Looking at Internet-era companies is important, because that category includes every company founded today and in the future. It is also important because of the opportunity it presents to examine the integration of ICT into the everyday lives of workers without also contending with the question of technological determinism, which assumes that technology drives change rather than existing in dialogue with social and institutional forces (Kling, 1996; Kling, Rosenbaum, & Hert, 1998; Orlikowski, 1992; Orlikowski, 1996). While some work has been done on Internet-era companies, more research is needed across other industries and types of workers (Teigland, 2000).

In this research, we examined the role of technology in supporting information access in a software and services company in the high-technology industry. Survey data collected via a web-based questionnaire from 27 employees are enriched with in-depth interviews and observations with a sub-sample of 10 employees. While the research also encompassed social interactions and organizational culture, our focus in this paper is on how workers obtain information they need to perform their jobs. Specifically, our goals are:

(1) To better understand the information sources used by workers, and the ways they access those sources.
(2) To examine whether type of information source and access have an influence on individual performance.

Theoretical Background

Information sources and access

Many studies have documented that, when seeking information, people prefer *human* to *documentary* information sources. Human sources include coworkers, managers, and other colleagues outside the organization. Documentary sources include such items as reports, databases, memoranda, and web sites.

This preference for human sources existed before ICT became prevalent in business organizations. More than twenty years ago, a study found that engineers were roughly five times more likely to turn to a coworker or other colleague for information than to use a documentary source (Allen, 1977). But the preference also appears in more recent work on other populations, such as executives in the telecommunications industry (Choo & Auster, 1993; Choo & Auster, 1994)

The telecommunications executives considered human sources most valuable because they "filter and summarize information, highlight the most salient elements, interpret ambiguous aspects, and in general provide richer, more satisfying communications about an issue" (Choo, 1998a, p. 31). Workers in other roles report "learning much more by studying on their own and discussing with co-workers than from formal sources or other external sources of expertise" (Clement, 1990 p. 226; see also Wenger, 1998). In some circumstance, human sources may also be uniquely valuable because of the nature of the work being performed or the nature of the information sought.

Further evidence supporting the importance of human sources of information comes from research into communities of practice. A community of practice is a group of people who come together informally to support and learn from one another in accomplishing a given task (Lave & Wenger, 1991; Wenger, 1998, 2000). Among the workers who have been studied as communities of practice are service technicians (Orr, 1996), fishermen (Miller & Van Maanen, 1979), and architects (Salaman, 1974). Theories of communities of practice see organizations as sense-making systems (Weick, 1995); that is, as social systems in which people interpret and give meaning to information about their work. Communities of practice allow workers to create shared understandings of situations and problems, as in the case of the Xerox technicians studied by Orr (1996).

By revealing how social relationships influence the flow of information (Allen, 1977), social network analysis has shed light on how communities of practice operate. For problem-solving, the exchange of information outside of formal meetings and hierarchical boundaries is essential for getting work done (Hinds & Kiesler, 1995; Nardi, Whittaker, & Schwarz, 2000). These informal social networks provide new information, answer requests rapidly, and help solve problems (Cross, Borgatti, & Parker, 2001; Cross, Rice, & Parker, 2002; Haythornthwaite & Wellman, 1998). A common language and frame of reference facilitate this exchange. Therefore, our first proposition is as follows:

Proposition 1: Human information sources will be accessed more frequently than documentary sources.

A reliance on human sources has its limitations. First, when a person leaves the organization, this person's knowledge is also lost. Second, in large organizations

human sources are often distributed across the country or across the world, and it can be difficult to determine who knows what, and/or to obtain information from an unfamiliar or geographically distant source. Finally, reliance on human sources, particularly human sources accessed though traditional, non-ICT means, can be costly in terms of labor and time, and even reduce the potential for innovation by limiting the flow of ideas across boundaries (Teigland & Wasko, 2002).

In fact, it is to overcome these limitations that large investments in ICT have been made (Alavi & Leidner, 1999; Davenport & Prusak, 2000; Fulk & DeSanctis, 1995). Initially, investments focused on capturing information in documentary sources (Hansen, Nohria, & Tierney, 1999). More recently, ICT strategies have shifted to include greater focus on enabling access to, and interaction with, human sources (Hansen et al., 1999; Teigland & Wasko, 2003).

The result of these ICT investments is that workers have a wide gamut of information sources available, both human and documentary. Given our concern in this study with the role of technology in information gathering, we divide those sources into two categories: online and offline. For the purposes of this study, we use these terms as equivalent with "computer-mediated" and "non-computer mediated," since the distinction is not significant for Internet-era firms.

How do workers choose a given source and access mode for acquiring information? Research has shown that the factor that most influences the selection of an information source is accessibility (Leckie, Pettigrew, & Sylvain, 1996; Pinelli, 1991; Pinelli, Bishop, Barclay & Kennedy, 1993). Fidel & Green (in press) have shown that definitions of accessibility vary widely. Their research with engineers found accessibility comprising as many as a dozen different factors, including format, level of detail, familiarity, searchability, timeliness, and physical proximity.

Though many of the factors of accessibility seem to favor online access, access to human sources still seems most effective when conducted offline. People often need to meet face-to-face to exchange experiences and especially what has been referred to as tacit knowledge or deep insights (Brown & Duguid, 2000). Online systems for enabling human sources to share their knowledge are often not as successful as predicted (Markus & Keil, 1994; Orlikowski, 1996). Although video and telephone conferencing is available, people still travel across the globe for business meetings (Cohen & Prusak, 2001). Therefore, our proposition with regard to human sources is:

Proposition 2a: Human information sources will be accessed more frequently offline than online.

For documentary sources of information, online access appears to satisfy many of the factors that make up accessibility. Sources available online are typically known (or easily locatable), combine many different types of information in one place, are searchable, are available at any time, and are interactive (searches can be refined).

For that reason, our proposition with regard to documentary sources is:

Proposition 2b: Documentary information sources will be accessed more frequently online than offline.

Individual performance

Access to information is central to the performance of any organization (Choo, 1998a, 1998b; Galbraith, 1973). This is because employees are limited in their abilities to solve problems and make decisions, a condition referred to as bounded rationality (Simon, 1988, 1996). In order to overcome bounded rationality, employees need to acquire the right information to solve problems and make the right decisions (Allen, 1977; Jarvenpaa & Ives, 1994). Indeed, research has shown that effective use of information does lead to better performance (Constant, Sproull, & Kiesler, 1997).

Research has also shown that the key factor influencing the use of information in organizations is access (Allen, 1977; Fidel & Green, in press; Gertsberger & Allen, 1968). The findings show that if an information source is difficult to access – either because it is physically distant or it is otherwise difficult to use – workers will be less likely to seek information from this source. Hence, the ways information sources are accessed can be expected to have a major impact on performance.

Few studies have been conducted into how modes of accessing information affect individual performance. However, it is obvious that information captured in databases, knowledge repositories, and other digital formats is more accessible than that same information would be in paper form, if only because ICT provides access across the boundaries of space and time. With information sources a "click" away, employees can use these resources to better solve problems. Therefore, we should expect to find in our case that electronic searching and retrieval of documentary sources would result in improved performance for workers who access those sources online:

Proposition 3a: Online access to documentary sources will have a higher association with individual performance than offline access.

ICT also provides new means to access human sources. Such tools as email, instant messaging, and bulletin boards facilitate the sending and receiving of messages and other digital information, and create dense social networks of information exchange (Haythornthwaite & Wellman, 1998; Sproull & Kiesler, 1991). Employees can communicate across the organization from the comfort of their desktops, which should also yield increases in productivity (Hinds & Kiesler, 1995).

Nevertheless, there are concerns that the use of ICT for accessing human sources may not have a positive impact on performance. These concerns are twofold. First, many types of information from human sources are not easily transferable via ICT. A

series of studies showed that computer-mediated communication lacks social cues that are important to facilitate the transfer of complex and uncertain messages (Daft & Lengel, 1986; Kiesler & Sproull, 1992; Lengel & Daft, 1988; Trevino, Lengel, & Daft, 1990). Further, theories in the field of knowledge management suggest that tacit knowledge – defined as insights, values, and experience-based knowledge – is transmitted primarily through face-to-face interactions (Cohen & Prusak, 2001; Nonaka & Takeuchi, 1995). Therefore, we would expect that, where human sources are concerned, offline access would be associated with higher performance:

Proposition 3b: Offline access to human sources will have a higher association with individual performance than online access.

Research method and design

Setting

To examine the above propositions, we undertook research at a software and services company in the high-technology industry. This company, located in a large North American city, will be referred to by the pseudonym KME.

Three criteria were important for selecting KME as the site for the study. First, KME is an organization that was founded in 1997 when Internet technologies were widely available in the United States, and has incorporated ICT into its operations from its founding. Hence, KME is not an organization that first operated in the time before the Internet and then adapted to ICT. Second, KME is an organization in the service sector and employs knowledge workers who extensively use a wide variety of information sources in their daily work activities. The company's products and services enable its customers to implement successful collaboration projects among customers, employees, or partners. Third, KME operates in a fast developing area and thus needs to be constantly developing new products and services and fine-tuning existing ones in order to meet customer needs and to remain competitive. Particularly in the services area of the business, processes and practices are not well established in the industry, and are therefore being created, tested, and evolved as part of everyday work.

KME has 80 employees. We selected for our sample 28 employees in total from the product development and management services groups, representing 35 percent of the total employee population. These two groups were selected because they have existed as functional groups for at least one year and the tasks accomplished within each group are interrelated and fairly homogeneous. Hence, we expected to find stable patterns of use of information sources and technology. Of the 28 employees

selected, 27 completed the questionnaire yielding a 96 percent response rate[1]. Before administering the questionnaire, a pilot test was conducted with six respondents.[2] The numerical data were supplemented by in-depth interviews and observations with a sub-sample of 10 employees. There were four women in the sub-sample; this ratio is approximately representative of the gender distribution in the complete sample. Five respondents from each group were chosen. Participation in the interviews and observations was voluntary.

Survey

The main source of data collection was a web-administered survey. Each respondent was provided with a username and password to access the site. All responses were collected on a secure server. The key variables were information sources and access, individual performance, social interactions, and organizational culture as it pertains to knowledge sharing.[3] The variables relevant to this paper are discussed below.

Information sources and access. To measure employees' use of various information sources, we draw from previous research into how information and knowledge is stored and used in organizations. Because ICT presence in organizations has only reached today's levels over a period of many years, past research has not always made a clear distinction between online and offline sources. Useful distinctions made in past research include personal versus impersonal (Choo & Auster, 1993; Choo & Auster, 1994) and human versus documentary (Fidel & Green, in press). Related distinctions arising from theory include tacit versus explicit (Nonaka & Takeuchi, 1995), and codified versus personalized (Hansen et al., 1999).

We have followed Fidel and Green in distinguishing between human and documentary sources, and make an additional distinction between online and offline methods for accessing those sources. Our use of these terms, and the list of items we include under each category of sources, are modified to conform to an Internet-era company and the specific technologies available at KME. The list of items is presented in Table 1. For each item, we asked respondents to indicate their frequency of use on a 7-point Likert scale [1=never; 2=a few times a year; 3=1/month; 4=1/week; 5=several times a week; 6=1/day; 7=several times a day]. Based on factor analysis of these items, new scales were computed. The items "Internal Memoranda, Circulars" and "Company Library" were excluded from the scale measuring use of

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1 We do not expect a non-response bias in the sample because the one employee who did not participate was on holidays at the time the survey was administered.

2 Three respondents were not employed by KME, and three were employed by KME, but were not members of either target group. The pilot tests served to provide feedback about the length of the questionnaire and the appropriateness of the wording of items.

3 As noted earlier, social interactions and organizational culture will be addressed in future papers.

offline documentary sources because they did not show sufficient variance, with most employees responding "never."[4]

Individual Performance. The most commonly accepted measures for employee performance are productivity and efficiency (Hall, 1997; Heneman, 1974). However, these measures are not generally maintained for all categories of workers. Even when they are maintained, it is often unclear what they reflect, because there are different ways in which they can be operationalized (Teigland, 2000). In the present study, self-reported ratings of individual performance are used because the company does not maintain quantitative metrics that are consistent across individuals in the sample.

We measured individual performance using four items in the questionnaire. Participants were asked to rate, on a 5-point Likert scale ranging from "strongly disagree" to "strongly agree," their perceived ability to solve problems effectively. The first and second items are modifications of the items employed by Teigland and Wasko to measure individual performance (2002). These two items ask participants to rate their effectiveness in solving problems and the creativity of their solutions. The third and last items measure a person's perceived contribution to finding a solution.

The four items were collapsed into a single measure of individual performance. Although self-reported measures may seem to be biased in favor of the respondents, some evidence suggests that they are not upwardly biased (Churchill, Ford, Hartley, & Walker, 1985). In the present study, we find that the items have no deviation from the normal distribution. See Table 2 for scale properties.

Interviews and observations

As noted, the study does not rely solely on self-reported data, but also includes rich, contextual data obtained through interviews and observations. The interviews asked group members about how they obtain information for work-related purposes. It also includes a critical incident technique to learn about how they use various information sources to solve ill-defined problems.

This research differs from other studies by using an ego-centered observation approach. That is, instead of observing an entire group or division, we observed single employees. These one-day long in-depth observations provide rich data about all the ways in which a group member obtains information. The triangulation of quantitative and qualitative data serves the purposes of explaining the patterns of interaction and communication that result from the study.

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[4] Similar results were found for the regression analysis that when the scale measuring offline documentary sources was used that includes "Internal Memoranda, Circulars" and "Company Library."

Documentary Sources	
Offline	***Online***
(Non-Computer-Mediated/Printed)	***(Computer-Mediated)***
Newspapers	Newspapers
Periodicals	Periodicals
Internal Memoranda, Circulars	Internal Memoranda, Circulars
Company Library (Books, Tapes, etc.)	File Directories, Databases, Repositories
Newsletters	Newsletters
Human Sources	
Offline	***Computer-Mediated***
(FTF Meetings, Phone Calls, Lunches)	***(Email, Instant Messaging, Bulletin Boards)***
Colleagues Outside the Work Group but Within the Organization	Colleagues Outside the Work Group but Within the Organization
Colleagues Within the Work Group	Colleagues Within the Work Group
Superiors, Other Executives	Superiors, Other Executives
Customers	Customers
Competitors	Competitors
Business Partners, Vendors	Business Partners, Vendors
Conferences, Trips	Conferences, Discussions
Personal Friends Outside the Organization	Personal Friends Outside the Organization
Colleagues Outside the Organization	Colleagues Outside the Organization
Non-electronic Bulletin Boards	Online Bulletin Boards
Individual Performance	
I can quickly recognize the complexities in a situation and find a way of solving problems.	
My work tasks demand creative and totally new ideas and solutions.	
I feel that the solutions I provide are not very helpful.	
I feel confident that my work has contributed to the success of the organization.	

Table 1. List of Items

Scales	**Range**	**Mean**	**S.D.**	**Cronbach's α**[a]	**# Items**
Documentary Offline	1-7	2.63	1.02	.61	3
Documentary Online	1-7	4.31	1.24	.69	5
Human Offline	1-7	3.02	0.62	.60	10
Human Online	1-7	3.90	0.94	.74	10
Performance	1-5	4.14	0.57	.73	4

[a] Measure of reliability.

Table 2. Scale Properties

Results

Profiles of respondents

The web-based questionnaire was administered to 27 participants in two groups; 11 (3 females) participants in the product development group and 16 (5 females) in the management services group. Respondents had worked for KME for an average of 28 months (range 5-48 months). Employees in the product development and management services groups had worked an average of 15 months and 37 months, respectively, reflecting the fact that the company had started its product development efforts only in 2001. Twenty-two percent of respondents had a high school diploma or less, 44 percent had completed an undergraduate degree, and thirty percent had a graduate degree. The sample included 3 upper managers, 5 middle managers, and 19 group members.

Interviews and observations were conducted with a sub-sample that included 10 employees, 5 respondents from each group. Participation was voluntary. The sub-sample consists of 40 percent females[5]. Interviews lasted about 45 minutes and the observations lasted for an entire workday (approximately 9 a.m. to 5 p.m.). To ensure anonymity, respondents are referred to by pseudonyms and gender, hierarchical position, and other identifying characteristics are omitted.

Information sources and access

Figure 1 shows the frequency of use of human and documentary sources. We predicted that employees would use human sources more frequently than documentary sources for work-related purposes. We also predicted that documentary sources would be more frequently accessed online than offline, whereas human sources would be more frequently accessed offline than online. We tested these predictions by conducting a 2x2 repeated-measures analysis of variance (ANOVA) with type of information source and type of access as within-subjects factors.

Results of this analysis revealed no effect of type of source, $F(1,26) = 0.70$, $p =$ n.s.; an effect of type of access, $F(1,26) = 103,78$, $p < .001$), as well as an interaction between type of source and type of access $F(1, 26) = 32.11$; $p < .001$. Simple comparisons were conducted to test the source of the interaction. We find that documentary sources are more likely to be accessed online than offline $t(26) = 9.72$, $p < .001$. Similarly, human sources are more likely to be accessed online than offline $t(26) = 6.96$, $p < .001$.

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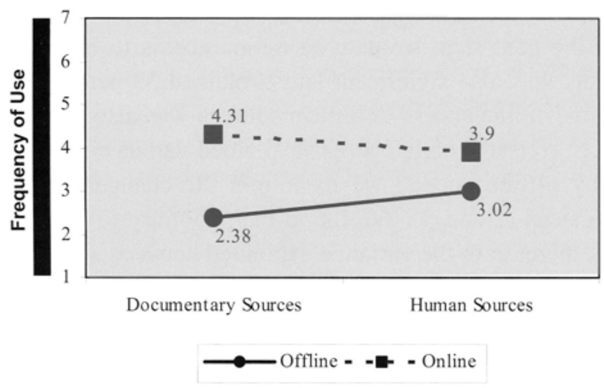
[5] This female to male ratio is approximately representative of the gender distribution in the two groups.

Figure 1. Information Sources and Performance



Contrary to Proposition 1, we found that documentary sources (M = 3.34) were used as frequently as human sources (M = 3.45). We also found that, contrary to Proposition 2a, human sources were accessed more frequently online than offline. Our finding for Proposition 2b supported the proposition: documentary sources were accessed more frequently online than offline.

Individual performance

Table 3 reports results of a hierarchical regression analysis that tested whether or not types of information sources and access predicted performance. The aim was to test if online access to information sources predicted variance in performance beyond that already predicted by offline access. We predicted that with regard to documentary sources, online access would explain variance in performance beyond that associated with offline access. To test this we entered each variable to the regression equation in a separate step. In the first step, we entered several control variables (including time with organization, education, and hierarchical position) that may influence performance, but are not the focus of the study. None of these variables were associated with performance. In the next steps (2 and 3), we entered offline access and online access to documentary sources sequentially. The models did not reach statistical significance, indicating that neither online nor offline access to documentary sources was associated with performance. Hence, there was also no significant increase in the explained variance between steps 2 and 3 for documentary sources.

With regard to human sources, we predicted that online access would explain variance in performance beyond that explained by offline access. Again, to test this we entered each variable into the regression equation in a separate step. The control

variables, which were entered in the first step, again revealed no association with performance. In the next step we entered offline access into the model. We found that this model reached statistical significance explaining 26 percent of the variance in performance. Offline access to human sources was found to be associated with performance. In the next step, we entered online access to human sources into the model. This model was also significant and explained 53 percent of the variance in performance. Thus, online access to human sources was also found to be associated with performance. To test if online access explained variance in performance beyond that explained by offline access, we examined the change in variance explained between the two steps (2 and 3). We found that, contrary to our expectations, there was a significant increase in the variance explained between steps 2 and 3, $F(1,18) = 18.46$, $p < .001$, indicating that after controlling for offline access, online access amounted for a significant proportion of variance in performance.

In sum, we found no support for Proposition 3a; documentary sources were not related to performance; neither access via online nor offline. With regard to human sources, we found that, contrary to Proposition 3b, after controlling for offline access, online access amounted for a significant proportion of variance in performance.

	Performance				
	Step 1[a]	Step 2[a]	Step 3[a]	Step 2[a]	Step 3[a]
Time working	0.09	0.08	-0.02	0.04	-0.08
Education (reference=bachelor)					
High school or less	0.04	0.07	-0.02	-0.02	-0.14
Graduate degree	-0.29	-0.27	-0.38	-0.14	-0.18
Hierarchical position (reference=management)					
Group member	0.29	0.32	0.32	0.38	0.47*
Upper management	0.33	0.33	0.37	0.19	0.35
Documentary					
Offline	–	0.15	0	–	–
Online	–	–	0.35	–	–
Human					
Offline	–	–	–	0.59**	0.05
Online	–	–	–	–	0.77**
Adjusted R^2	-0.06	-0.09	0.03	0.26*	0.53**

* $p < .05$, ** $p < .01$, *** $p < .001$.
[a] Standardized (beta) coefficients.

Table 3. Information Sources and Performance

Interviews and observations

When individuals seek information, they make choices. These choices are to some extent personal: they are based on the individual's view of what sources and access methods would be easier, faster, or more effective. However, they are not made in a vacuum; they are greatly influenced by organizational factors. Interviews and observations at KME revealed that organizational factors were a very strong influence on the information seeking habits of most employees. In the paragraphs below, we discuss three organizational factors that were most salient: pace of work, workspace configuration, and norms for interaction and information management. Although we discuss each factor separately, we recognize that they are interconnected.

Pace of Work. The advantage of computer-mediated communication in bridging space and time constraints, thereby speeding up communication, is one reason for its dominance at KME. Like other companies in the high-technology industry, KME operated at an unusually rapid pace. Day-long observations revealed that KME employees were often performing three or four operations at the same time, including multiple separate conversations happening in instant messaging and email, and that deadlines for work in process were typically within the day rather than the week or month.[6] In such an environment, it is essential that employees can access the documents they need quickly, from the convenience of their desktops.

For accessing human sources, the advantages of online access go beyond bridging time and space. Employees at KME often needed to solve problems that consist of interdependent tasks. Employees chose to use online means for information exchange because it allowed them to quickly send and receive messages with a large number of employees – either simultaneously or sequentially. In order to coordinate sub-components of work tasks, connectivity in real time is pivotal to avoid delays. While the phone and face-to-face communication would offer similar capabilities, neither was flexible enough for the type of high-frequency communication required at KME. Further, they did not support multi-tasking in the same way as email and instant messaging did. Employees could be working and simultaneously receiving email and instant messages without being interrupted. They could note the arrival of an instant message or email without abandoning their work, and reply later at a time that was more convenient.

Workspace Configuration. In this organization, the physical properties of the office influenced information habits. For example, the absence of a central paper file system for reports or other documents may help account for the great predominance

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[6] The product development group typically has longer timeframes than the management services group, but the the complexity of their work means that the level of intensity is similar between groups.

of online versus offline access of documents. We found that documents were accessed online once a week on average, versus a few times a year for documents accessed offline. Limited storage space for individuals may also help account for this difference.

Workspace configuration also impacted how human sources are accessed. KME had limited office space and employees were sited in small cubicles in very close proximity. Employees reported that they often opt to use email and instant messaging because it was less disruptive to those sitting around them than would be holding a conversation (either face-to-face or via phone) at their desk. Perhaps ironically, technology here is not used to bridge distance, but to overcome the disadvantages of proximity.

Norms for Interaction and Information Management. Consistent with our quantitative findings, norms concerning documentary sources favor online access. Typical documentary formats include MICROSOFT WORD documents and MICROSOFT POWERPOINT presentations. Documents created for outside parties such as customers or partners were, with few exceptions, delivered in electronic form as attachments to email, not as hard copy shipped though the mail or overnight service. This norm was reinforced by the fact that most interactions with outside parties were conducted via phone rather than in face-to-face meetings where it would be customary to hand out copies of the documents to be discussed. Documents created for internal use were always exchanged and stored in electronic form, although they were printed out when under discussion in face-to-face meetings. Paper documents received from outside parties were typically stored in paper form by a KME employee involved with the relevant customer or project. Not surprisingly, the location, access, and retention of these documents were less convenient and reliable than for electronic documents.[7]

Norms for human sources favored online access as well. It was not uncommon for a KME employee to ask a coworker to "send me an email" rather than continue a face-to-face conversation where complex or highly detailed matters were being discussed. It was understood that using email would create a convenient record or reminder of the items being agreed to or discussed. Observations showed that employees exercised considerable care in crafting emails when they knew the emails were likely to be retained and referred to in the future. Even where face-to-face or phone interaction was required, most KME employees adopted the convention of contacting the source first via instant messaging or email to confirm whether they are available to talk.

It is worth noting that face-to-face interactions were nevertheless a large part of how KME operated. As our quantitative results show, human sources were accessed

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[7] Contracts and other financial and legal documents are stored separately in customer files maintained by the finance department, which was not one of the groups included in this study.

offline on average once a month, versus once a week online – that is, more online than offline, but not nearly the predominance that existed for documentary sources.

Conclusions

The goal of this study was to obtain a better understanding of how workers at an Internet-era company use information sources and access those sources. The study found that, based on the data from one company, Internet-era companies may exhibit different patterns in information seeking than do traditional companies. Specifically, workers at Internet-era companies reverse the traditional preference for offline versus online access to human sources. A further finding shows that online access for human sources may be preferred because it is more effective – that is, that such access is associated with higher individual performance, as performance is subjectively perceived by the individual.

Several other insights emerged in the course of this study that may have implications for future research. First, it is clear that ICT has significantly complicated the distinction between human and documentary sources. Most people would agree that a conversation with a coworker involves a human source, and that a document from a filing cabinet involves a documentary source. But when ICT is involved, the difference may be less a matter of kind than of degree. For example, when an employee obtains information from an email sent by a coworker, the source is obviously human. But what if the email is two years old, and the employee retrieves it not from the source, but from storage on his or her own computer? Or if the employee retrieves it from a repository, where another employee has placed it as something that might benefit others? Our research indicates that employees are consciously aware that the information they share with, or receive from, coworkers may have a "second life" as a documentary source, and are adapting their behavior accordingly. An area for future research is to focus on how these conversion processes occur, and how they can be optimized.

Another learning relates to the use of ICT to overcome the problems of a densely crowded workplace. In a study of a high performance team, the fact that everyone could hear what everyone else was saying was perceived as an advantage (Mark, 2002). The difference is that employees in the present study are not working on the same problem. While the tasks are interdependent, there is little overlap. Thus, the pattern of access to sources shows a complex relationship between computer-mediated communication and productivity. In general, the advantage of computer-mediated communication is seen in its capacity to bridge space and time constraints thereby speeding up communication (Sproull & Kiesler, 1991). By contrast, in the present study, we found that computer-mediated communication supports local

communication. The advantage does not lie in its ability to bridge spatial barriers, but in overcoming local physical constraints. By relying on computer-mediated communication employees can communicate without interrupting each other's work.

The high reliance on online ways of accessing human sources is particularly interesting in light of the fact that employees in this organization are co-located. We introduce the term *virtual localities* to describe bounded physical places where people communicate via computer-mediated means, creating dense networks of exchange. The fact that people are not interacting visibly in public spaces does not mean that they are in isolation. They are going online to send and receive emails, to chat with colleagues via instant messaging, or to post questions to a bulletin board. This finding is contrary to theories of network and virtual organizations, which argue that computer-mediated communication creates sparsely-knit, boundary spanning structures (Monge & Contractor, 1988, 1997; Monge & Contractor, 2003; Monge & Eisenberg, 1987). We found that computer-mediated communication also creates dense, local networks of information exchange. Thus, the Internet is contributing to new and unexpected forms of interaction and community in organizations, which blend computer-mediated communication for both local and distant interactions.

While the purpose of this study was to examine how Internet-era companies use and access information sources, there are many areas of research that remain unexplored. First of all, we only examined frequency of use and did not collect data on the time employees spent using an information source. Thus, the next step would be to conduct a more detailed analysis looking at the time employees spent on each source. Second, although we related use of information sources and access to performance, we do not have data mapping the usefulness and quality of single sources. It would be interesting to see how employees evaluate specific sources in the context of their work. Third, we measured individual performance using employee's self-rating. To strengthen the validity of performance, it would be useful to employ a third-party measure of performance. Fourth, this study is based on a single organization reducing the generalizability of the results to other companies. We believe however that the findings can serve as a baseline for future research on Internet-era companies.

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Communities and other Social Structures for Knowledge Sharing - A Case Study in an Internet Consultancy Company

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Abstract. This research aims at understanding how people share knowledge in their everyday work in a project-based company. The social structures for knowledge sharing are characterised as formal, informal, and quasi-informal structures. They vary from those with high formalisation to the informal, and even include structures which are invisible and unrecognised in the organisation. They also vary in their composition. They may share the same or different space, and communication is based on face-to-face or virtual interaction. Data was collected by means of documents and interviews (n=18) during the autumn of 2002 and the winter of 2003 from an Internet consultancy company. The study shows the great variety of formal, informal, and quasi-informal social structures that are used for knowledge sharing in the case company. In all, sixteen different structures were found. The number of formal structures is smaller than the number of informal ones. Their analysis in terms of five dimensions also shows their great heterogeneity.

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Introduction

The challenge of knowledge sharing in project organisations

Organisations are becoming more project-based than before, and results are delivered to customers through projects. Organisations are often multi-project environments, where several projects constitute a major part of the business and several project assignments are under implementation simultaneously (e.g. Frame, 1995; Gareis, 2000; Turner, 1999; Engwall, 2000). In this study, the organisational context is a project organisation. Project-oriented working models are becoming more widespread, because they offer, among other benefits, organisational flexibility (Rolstadås & Kolltveit, 1999). One of the challenges in a multi-project environment is sharing knowledge among projects: how is it possible to prevent the "reinvention of the wheel" and share knowledge accumulated in one project with others? This requires us to focus on finding competence and knowledge-sharing mechanisms on both organisational and individual levels (e.g. Crawford, 1999).

Basically, knowledge sharing is based on two strategies (Hansen, Nohria & Tierney, 1999). The codification strategy relies on carefully codifying the knowledge and storing it in archives and databases, where it can be assessed and used over and over again. Examples of codified mechanisms are electrical learning environments and knowledge support systems, e.g. electronic performance support systems (EPSS). This strategy faces many difficulties: tacit knowledge and experience are difficult to identify and store and the storage itself is also time-consuming; additionally, codified knowledge loses its usefulness quite soon. In the personalisation strategy, knowledge is closely tied to the people who developed it (people as repositories) and is shared by personal face-to-face interaction. Examples of personalised mechanisms are learning by reflection and dialogues. The targets of this study are communities and other social structures as knowledge- and competence-sharing mechanisms.

People are basically willing to share their knowledge, but in order to do so they need to have a supportive environment. Constant et al. (1994) discovered that people distinguished between tangible information and intangible information, embodied as human memory, knowledge, experience, or a skill. Although they were willing to share both, the motivation for sharing intangible information was lower. They felt that it had, to a great extent, become part of their identity and self-worth. This intangible information was shared more easily if people gained personal benefits from sharing it. This emphasises the importance of face-to-face communication (Dixon, 2000). Face-to-face interaction increases the sense of safety and promotes virtual interaction as well (e.g. Cross et al., 2001). Sharing

must result in not only organisational outcomes but personal benefits as well (Wenger, 1998; Dixon, 2000).

This paper reports the results of a case study on the communities and other social structures that are used for knowledge sharing on an intra- and inter-organisational basis in an Internet consultancy company. This paper focuses on informal and work-related social structures. Information and communications technology for knowledge sharing are not discussed in this paper. In particular, personalised mechanisms for knowledge sharing have not been widely studied in the project context. First, a short description of the current literature on social structures for knowledge sharing is provided, and then the results of the case study are presented and discussed.

Formal and informal structures in organisations

Scholars have distinguished between formal and informal organisational structures. The main problem with formal organisational charts is that they do not show the informal social relations that exist between company employees. Buchanan and Huczynski (2001) argue that formal organisation refers to the collection of work groups that have been consciously designed by senior management to maximise efficiency and achieve organisational goals. Informal organisation, on the other hand, refers to the network of relationships that spontaneously establish themselves between members of the organisation on the basis of their common interests and friendships. These are formed across functions and divisions (Krackhardt & Hanson, 1993).

Historically, organisational scholars have made important theoretical and empirical distinctions between formal and emergent networks (Monge & Contractor, 2000). Emergent structures have been seen as being more worthy of study than formal ones, because they are seen as promoting a better understanding of organisational behavior (Monge & Contractor, 2000; Krackhardt & Hanson, 1993).

Wenger (1998) argues that there are always two views of an organisation: the designed organisation and the practice that gives life to the organisation. The designed organisation is called an "institution" in order to distinguish it from the organisation as lived in practice, which gives life to the organisation and is often a response to the designed organisation. Both aspects contribute to making the organisation what it is and the organisation could be defined as the interaction of these two aspects. Organisations are social designs directed at practice. It is through the practices they bring together that organisations can do what they do. Wenger (1998) argues that an organisation is a constellation of communities of practice, and through these communities of practice an organisation knows what it knows and becomes effective and valuable as an organisation.

Networks and communication make possible informal communities

There are streams of communication network theories. Communication networks are described as the patterns of contact between communication partners that are created by transmitting and exchanging messages through time and space (Monge & Contractor, 2000, p. 440). They take many forms in contemporary organisations, including personal contact networks, flows of information within and between groups, strategic alliances between firms, and global network organisations (Monge & Contractor, 2000).

Informal communities as social structures emerge from those social networks that exist in an organisation or between them. Wenger et al. (2002) argue that community development begins with an extant social network. Important topics usually attract an informal group of people who begin networking. Networks may also remain invisible to others who are not involved in them. As informal networks of people with the ability and passion to develop competences already exist in organisations, the challenge is to identify them and help them to develop (Wenger and Snyder, 2000). This can be done, for example, by conducting a formal or informal social network analysis to identify who is involved in the networks and how strong the ties are (Scott, 1991). Relations are central to network analysis because they define the nature of the communication connections between people, groups, and organisations (Monge & Contractor, 2000, p. 441).

Networks are generally described as being looser than communities. Krackhardt and Hanson's (1993) study revealed three types of emergent relationships, which formed informal networks in organisations: advice networks, i.e. who depends on whom to solve problems and provide information; trust networks, in which employees share potential information and back each other up in a crisis, and communication networks, in which employees regularly talk to each other about work-related matters. They are formed across functions and divisions.

Networks have also been described as intentionally created. Dixon (2000, p. 9) discusses problem-solving networks, which are created to help groups to solve problems more efficiently and faster. British Petroleum's 'Peer Assist Programme' enables a team that is working on a project to call upon another team (or a group of individuals) that has had experience with the same type of task to work as temporary networks.

Nonaka and Takeuchi (1995) refer to redundant information, which promotes the sharing of tacit knowledge. Various organisational devices can be used for building information redundancy in organisations, for example, frequent meetings on both regular and irregular bases and formal and informal communication networks, which can facilitate the sharing of both tacit and explicit knowledge.

Organisations can promote community development by providing time and space, which promote communication. People communicate naturally in informal

spaces, usually outside the traditional hierarchies of an organisation. Nonaka and Konno (1998) distinguish the 'ba' from networks as a space where information resides. The ba is a specific time and space where knowledge is created in the organisation. The ba is a context for knowledge creation; it sets a boundary for interactions among individuals, and yet its boundary is open (Nonaka et al., 2001). Knowledge is embedded in the ba, where it is then acquired through one's own experience or reflections on the experiences of others. Nonaka and Konno (1998, p. 40) define it as a shared space for emerging relationships. This space can be physical (e.g. office, dispersed business space), virtual (e.g., e-mail, teleconference), mental (e.g., shared experiences, ideas, ideals), or any combination of them. Value creation in knowledge creation emerges from interactions within the shared ba. In the ba, the individual realises that he is a part of the environment on which his life depends. The individual ba is a part of the greater ba (basho), and it exists on many levels. The self is embraced by the collective when an individual enters the ba of the team. The team is the ba for individuals, and in turn, the organisation is the ba for the team. Finally, the market environment is the ba for the organisation. The ba is based on participation, which means getting involved and transcending one's own limited perspective or boundary.

Dixon (1997) uses the metaphor of 'hallways of learning' to describe organisational learning that takes place in organisations. Collective meaning is constructed, rather than discovered, among organisational members through dialogue, and it is something that members hold in common. Interaction with organisational members is based on discussion and cognitively organising what they know (Weick, 1995), and not just on speech and one-way interaction. Differences foster collective learning, and, therefore, hallways must involve multiple perspectives. Interaction and participation and a certain degree of informality are similar to how Wenger describes communities of practice. Dixon refers to meaning processes, which are also central in Wenger's work.

All in all, networks form the basis from which informal social structures, for example communities of practice, are born. These communities are driven by organisational members' shared interests and communication in a certain time and space.

Communities and other social structures for knowledge sharing

Wenger (1998) refers to 'Communities of Practice' as social networks that take place informally within and between organisations. Wenger et al. (2002) argue that communities as social structures have existed for as long as people have had the need for communication and interaction.

The terms 'community' and 'practice' together refer to a special type of social structure with a special purpose (Wenger et al., 2002). The concept 'community of practice' was first defined by Lave and Wenger (1991, p. 98) as:

> *"An activity system about which participants share understandings concerning what they are doing and what that means in their lives and for their community. Thus, they are united in both action and in the meaning that the action has, both for themselves and for the larger collective."*

According to Lave and Wenger (1991), the term 'community' does not necessarily imply co-presence, a well-defined, identifiable group, or socially visible boundaries. A community of practice is a set of relations among persons, activity, and the world, over time and in relation with other tangential and overlapping communities of practice. Lave and Wenger refer to legitimate peripheral participation as a process by which newcomers become included in a community of practice (Lave & Wenger, 1991). To open up a practice to newcomers, peripheral participation must provide access to all three dimensions of practice: to mutual engagement with other members; to their actions and their negotiation of the enterprise, and to the repertoire in use (Wenger, 1998, p. 100)

Brown and Duguid (1991) built on the practice-based theory of Lave and Wenger (1991), Orr's investigation of knowledge practice, and Daft and Weick's interpretative account of enacting organisations. Brown and Duguid view communities of practice as non-canonical and not recognised by the organisation. They often cross the boundaries of an organisation and involve people from outside. As they see communities of practice as being emergent, the central questions involve the detection and support of these emergent communities. They argue that group theory in general (e.g. Hackman, 1990) focuses on groups as canonical, bounded entities that lie within an organisation. Brown and Duguid (1991) argue that there is a remarkable gap between canonical and non-canonical practices in work. This means that there are significant differences between the way the work is documented and the way it is actually performed. When facing problems, people rely on solutions that are not provided by the formal structure. Informal mechanisms and systems, such as conversation with others, mentoring, and storytelling are then used.

Wenger (1998) developed the concept further. He takes as his basis the social theory of learning, which views learning as social participation. The main traditions that have affected his thinking involve, on one hand, theories of social structure (e.g. Giddens' structuration theory) and theories of situated experience (e.g. Schön). On the other hand, theories of practice (Lave, Bourdieu, Vygotsky) and theories of identity (e.g. Strauss, Giddens) are also central. In the area of theories of structure and theories of practice, theories of collectivity address the formation of social configurations of various types, from the local to the global, and define basic types of social configurations (Wenger, 1998).

Wenger et al. (2002) define a community of practice as "a group of people who share a concern, a set of problems, or a passion about a topic, and who deepen their understanding and knowledge of this area by interacting on an ongoing basis". Liedtka (1999, p. 5) describes them as being composed of groups of individuals united in action.

Botkin (1999) refers to 'Knowledge Communities' as groups of people with a shared passion to create, use, and share new knowledge for tangible business purposes. The main difference with communities of practice is in the formalisation of knowledge communities and in the link to business goals. Botkin views communities of practice as informal groups, shaped by circumstances and visible only to social anthropologists. Instead, knowledge communities are purposely formed and their purpose is to shape future circumstances. They are also highly visible to everyone in the organisation. The existing communities of practice, according to Botkin, need to be made visible by formalising them. Wenger (1998) emphasises the informal nature of communities of practice. Knowledge communities are usually based on a product or service, markets or clients, function, or geography and are reminiscent of matrix management (Botkin, 1999). Furthermore, Botkin (1999) argues that knowledge communities are similar to communities of practice in the way the work gets done and how participation gives identity and meaning to their members' work. Botkin (1999) views knowledge communities as the next step beyond teams and task forces. They are larger than task forces and live longer than teams. They are like departments, but cross-functional.

'Strategic communities' differ from communities of practice as they are created by management to address broad strategic objectives and are focused on achieving specific goals (Storck and Hill, 2000). They have a clear relationship to formal organisational objectives. The long-term value they are seen as providing comes through learning, innovation, and knowledge transfer. Communities of practice are voluntary groups; strategic communities, however, are quite deliberately established by the management. Storck and Hill (2000) call these groups 'communities', because they differ from traditional teams since they are not integrated into the management process but the corporate intervention is rather minimal. They are 'strategic' in the sense that their members' activities focus on a broad goal that is integral to overall business strategy. (Storck & Hill, 2000, p. 67).

The discussion shows the variety that exists in the degree of formality and formalisation in communities. They may be very formal and have an institutionalised status in the organisation (e.g. Botkin, 1999; Storck & Hill, 2000), while others are based on ad hoc relationships and are very informal (e.g. Krackhardt & Hanson, 1993), and not even recognised by the organisation (Brown & Duguid, 1991). Wenger (1998) also recognises the variance in the level

of formality within the communities, but refers to communities of practice as informal structures in organisations.

Communities also vary in the way they cross organisational boundaries. Andriessen et al. (2002) distinguish between intra- and inter-organisational communities. Intra-organisational communities of practice have been clustered under four clusters on the basis of their studies of Dutch companies (Andriessen et al., 2002, pp. 4–5). A 'daily practice community' consists of both experienced workers and newcomers, working in physical proximity and having mainly face-to-face meetings. A 'formal expert community' is a group comprising a limited number of dispersed experts. It is formally instituted, interaction being both face-to-face and via ICT. An 'informal network community' is a medium-sized group, spontaneously originated, freely accessible, and interacting informally, geographically widely dispersed and communicating mainly via ICT. Finally, 'problem-solving communities' involve a large number of geographically dispersed employees with the same function, and are focused on daily problem-solving through email questions and answers. Additionally, they describe inter-organisational communities, whose members come from different organisations. These are generally of the formal expert and informal network types.

Communities may enhance boundary-crossing within the organisation and involve a similarity or diversity of competences. McDermott (1999) argues that communities of practice are particularly useful when cross-functional teams are the basic structures of the organisation. In project organisations relationships are maintained cross-functionally, which may increase knowledge sharing, yet at the same time, isolate people from their peers. Communities of practice are a way to knit people back together with their peers while maintaining the focus on cross-functional project teams. 'Learning communities' (McDermott, 2000) are formed around topics that are important to both the business and community members. At Shell, these learning communities are each responsible for managing the knowledge in their own topic area. As people are, at the same time, members of their teams and communities of practice, McDermott refers to what he calls a double-knit organisation. At the World Bank (Wenger et al., 2002), "Thematic Groups" have been established to strengthen knowledge sharing across the organisation, involving community leaders, community support functions, and systematic Web-based repositories and a website. Boundary-crossing is critical and can result in a deep kind of learning, as interacting across practices forces members to take a new look at their assumptions (Wenger & al., 2002).

Space and the media used to communicate also characterise the dimensions of communities. Interaction may also take place in a virtual world instead of real space and time (Nonaka & Konno, 1998). Rheingold (1993) defined virtual communities as social aggregations that emerge from the Net when enough people carry on those public discussions long enough, with sufficient human feeling, to form webs of personal relationships in cyberspace.

Palloff and Pratt (1999) argue that a virtual community requires a clearly defined purpose and a distinctive gathering place for the group. Virtual communities have been referred to as groups that use networked technologies to communicate and collaborate. They are designed, while communities of practice are emergent (Johnson, 2001). Wenger et al. (2002) prefer to call them 'distributed communities', as these communities generally connect in many ways, including face-to-face, although they may rely primarily on "virtual" communication. They use the term 'distributed' to describe any community of practice, which cannot rely on face-to-face meetings and interactions as its primary vehicle for connecting its members.

The development of the Internet and electronic communication tools has affected communication between people. Jarvenpaa and Tanriverdi (2003) argue that there are two forces affecting the development of companies' virtual networks. Firstly, information technologies make coordination across time and space boundaries possible. Secondly, products, services, and processes are becoming more knowledge-intensive and many products and services are being digitised and traded via virtual media.

Elements of informal and quasi-informal communities

Communities of practice, as described by Wenger and his co-authors, have a wide variety of dimensions and forms, and this sometimes makes it hard to distinguish them from other forms. There are many overlapping types, and though they share similar elements, they also have distinguishing elements. According to Wenger (1998), communities of practice are combinations of three elements, which can be used to distinguish them from other social structures: a domain of knowledge, which defines the key issues in the community; a community of people who care about the domain, and the shared practice that they create. The domain gives its members the sense of a joint enterprise and brings them together. The concept of practice points out that the community concentrates on the learning that takes place through working in practice.

Practice is seen as the source of the coherence of a community. This is characterised as having three dimensions. Firstly, membership is a matter of the mutual engagement of the participants. This allows for the dynamic negotiation of both tacit and explicit knowledge. Interaction builds trust between the members and this allows all sorts of subjects to be discussed (Wenger, 2000). Secondly, a community is a joint enterprise, which keeps the community of practice together and builds a sense of accountability to a body of knowledge. Thirdly, the members together develop a shared repertoire, which includes routines, words, tools, stories and so on (Wenger, 1998).

The concept of the negotiation of meaning is referred as a process by which people experience the world and engagement in it as meaningful (Wenger, 1998,

p. 53) Whatever people are involved in involves meaning. Wenger (1998) discusses two other community processes: participation and reification. Participation refers to the process of taking part and also to the relations with others that reflect this process. It suggests both action and connection (Wenger, 1998, p. 55). Participation is a way of learning (Lave & Wenger, 1991). Reification refers to the process of giving form to experience by providing objects that congeal this experience into "thingness" (Wenger, 1998, p. 58). The processes of participation and reification are a duality; they are two constituents intrinsic to the process of the negotiation of meaning, and their complementarity reflects the inherent duality of this process (Wenger, 1998, p. 66).

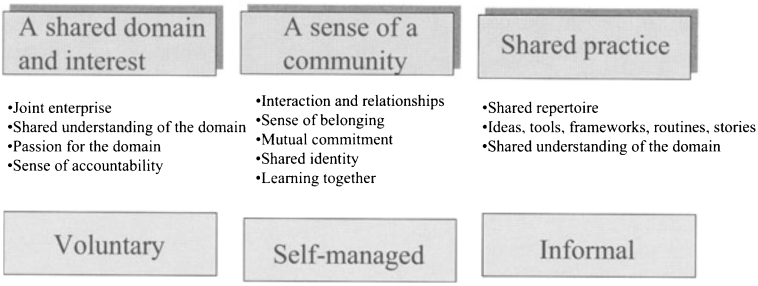

Figure 1: Basic characteristics of communities of practice (Wenger, 1998; Wenger et al., 2002).

To summarise the ideas of Wenger (1998; Wenger et al., 2002), the basic elements of the community of practice are (Fig. 1): domain; community and practice. They are central when distinguishing communities of practice from other types of social structures. In addition, a certain degree of voluntariness is required. Members are passionate about the domain. Interaction must be continuous. Communities of practice are also self-managed and loosely connected, as well as informal. They may be highly institutionalised in the organisation, but these other elements must still be present. Institutionalising means that they have a certain status in the organisation, but they are not a part of the official organisational structures in the way that, for example, business units are. They could be termed 'quasi-informal'.

Wenger et al. (2002) argue that communities of practice differ from business or functional units as they are more loosely connected, informal, and self-managed, even when they are highly institutionalised. Their relationships are based on collegiality, and memberships depend on participation rather than on institutional affiliation. In teams, members are to perform a set of interdependent tasks that contribute to a predefined, shared objective, as in communities of practice, the members' personal investment in the domain is central. Informal networks, communities of interest, and professional associations are seen more as a set of relationships, whereas communities of practice are "about" something,

their domain gives them an identity, and commitment to the domain provides cohesiveness and intentionality.

A study of the literature shows various dimensions and characteristics by which communities and other social structures are described. In this paper, formal, informal and quasi-informal social structures in the case company are described in terms of five characteristics. Firstly, the *degree of formality* varies in communities from the highly formalised to the informal. Boundaries are approached with two dimensions: intra- or inter-organisational structures (as also suggested by Andriessen et al., 2002), and the same is true of different competence areas. Communities may exist across *organisational boundaries* (Wenger et al., 2002). Intra-organisational structures involve members from only one company, while inter-organisational ones involve members from one or more organisations. *Competence diversity* varies from involving members from the same competence centre to involving members from different competence centres. Boundary-crossing is critical and can result in a deep kind of learning, as interacting across practices forces the members to take a new look at their assumptions (Wenger et al., 2002). In this case, competence diversity as a dimension is important, because boundary-crossing is critical in a project context and in this case company there are boundaries between different competence centres. Physical proximity is approached with a dimension; the *space* the members share varies from the same physical location to purely virtual structures, where members do not share the same physical space at all and instead are connected in a virtual space (as suggested by e.g. Rheingold, 1993). Finally, the dimension of *interaction* may vary from face-to-face communication to virtual communication.

Case Study: Satama Interactive, an Internet consultancy company

Objectives and research questions

The objective of this case study is to identify the social structures for knowledge sharing in the case company. The research aims at reaching an understanding of how people share knowledge and competences in their everyday work in a project-based company. The main focus is on the informal structures, which may vary from being invisible to others than the participants to highly formalised and recognised ones.

The main research question is: what kinds of communities and other social structures are there to create and share knowledge and competences in the case company – within and between offices, projects and client teams, and competence

centres, as well as across organisational borders? On the basis of the results, a typology of knowledge networks and communities is presented. The functionality and benefits of communities will be addressed by further research, and therefore these are not reported in this paper.

The case company

The case company is an Internet consultancy firm, 'Satama Interactive', that operates in four countries. The head office is in Helsinki, Finland, and there are sub-offices in Tampere and Oulu. There are also offices in Amsterdam, Düsseldorf, and Stockholm. The company is organised on the basis of four Competence Centres: Design, Technology, Consulting, and Project Management. Satama Interactive is a project organisation as all its activities are based on working on client projects. The company was founded in 1997, and today the company employs altogether 280 people in these four countries.

Research methods and procedure

The research methods used included documents and interviews. 18 people were interviewed. This number of respondents was selected in order to represent all the offices and competence centres and included people from various positions and with various tasks in order to represent multiple viewpoints and perspectives. The first four interviews were conducted in order to achieve a better understanding of the context and the case company. The interviewees were representatives of the administration and management. Networks and communities were also discussed with them. The other 14 interviews concentrated on communication, cooperation, and knowledge-sharing issues.

The research process was abductive (Dubois & Gadde, 1999). There were basic theoretical ideas on communities and other types of social structures for knowledge sharing. The interview themes were based on these concepts. They involved issues relating to intra- and inter-group relations and cooperation, communication, knowledge sharing and collaboration, and networks and communities. They were designed to find answers to the research question. All the interviewees were asked basically the same questions in order for reasonable and valid comparisons across informants to be capable of being made. This allowed the results to be analysed in a meaningful way. Although all the interviews involved the same questions, each informant was encouraged to explain different points in more detail if necessary (Johnson & Weller, 2002). Even though the analysis was based on the interview themes, emergent issues were allowed to appear, thus allowing greater rigour. There was an ongoing comparison with the existing theory, based on Dubois and Gadde (1999), who argue that the dialogue between theory and empirical data is ongoing and that the findings may affect the shape of the existing theoretical model.

The research was conducted during the autumn of 2002 and winter of 2003. Interviews were taped and transcribed verbatim. One interview, with a representative from the Stockholm office, was a phone interview. After the transcription, the interviews were analysed using a text analysis program, Atlas.ti. Data were classified on the basis of the themes of the interview, which in turn were based on the wish to find answers to the research question. Knowledge-sharing forums, cooperation, and relationships were further classified for each respondent. Similarities and differences were analysed and a typology of social structures for knowledge sharing was created. These structures were further analysed on the basis of the five dimensions already mentioned and three categories within each: formality (very formalised – fairly formalised - not formalised at all), organisational boundaries (members only from the company – some members from outside – members from different organisations), competence diversity (members from the same competence centre – members from some centres – members from all centres), space (all from the same location – some from other locations – all from different locations), and interaction (only face-to-face – face-to-face and virtual – only virtual).

The main challenge with this kind of research is that some of the social structures remain invisible to others and they may be difficult to identify. This is especially the case with the most informal structures.

Formal, quasi-informal and informal structures

Most communication takes place within predefined organisational structures, e.g. within offices, competence centres, and project teams. Project teams are major connecting structures between competence centres, as their members represent various competence areas. Most projects were within offices, yet there were some cross-office ones as well. There are several additional formal, quasi-informal and informal structures that connect professionals. In all, sixteen different social structures were found for knowledge sharing in the company.

Type 1: Professionals representing the same competence

Formal professional groups connect members from the same professional positions, such as project or client managers. Their purpose is to share knowledge between the professionals and discuss issues of mutual interest. They are intra-organisational. They are very formalised and work-related. Members are mainly from the same competence centre. They usually share the same physical space and communication takes place both face-to-face and virtually.

Competence-based communities involve members from the same competence area, such as consulting, design, and technology. Their purpose is to connect people within competences and help them share advice and experience. They are

fairly formalised and intra-organisational. Members usually share the same physical space and communication takes place both face-to-face and virtually. They are more loosely and informally connected than formal professional groups, which have nominated leaders, agendas, and regular meetings. The distinction between these two is in the degree of formalisation.

Peer groups appear on various levels. They are informal and emergent, as opposed to professional groups. A person may have a peer group that shares their immediate physical space, e.g. colleagues sitting in the same room. Relationships are very informal and continuous. There are also peer groups within the company who may not always share the same physical space. Peer groups are also inter-organisational. Peer groups are mostly within competence centres. Communication takes place both face-to-face and virtually.

Type 2: Cross-competence structures

Project teams, internal development project teams, strategic communities, SIG communities, interest groups, and personal networks usually consist of members with various competence areas. What keeps these structures together is a shared goal or shared interest. They may vary from highly formalised to very informal structures.

Satama Interactive is a project organisation, and the main structure for organising work is a project team. Project teams have goals of delivering client projects. Project work includes the project team and a project manager. Project managers work for the "Project Management" competence centre and act as professional project managers. Project members come from different competence centres. Projects have regular, formal meetings.

Internal development projects are temporary and have a formal status in the organisation. Their purpose is to develop concepts that are not directly related to any ongoing client project. They are formalised, and they involve a project manager and have an allocated, restricted time for developing a new idea or a concept. They are intra-organisational, involving members from different competence centres. Members working on a development project usually share the same physical space, but communication can take place both face-to-face and virtually.

Strategic communities are related to the company's strategy. Their purpose is to create new business potential and new client solutions, connect competences, and concentrate on strategically important issues. They are very formalised and have organisational support. Members may share the same physical space, but there may also be members from other offices. Communication takes place both face-to-face and virtually.

Cross-competence communities connect people from different competence areas and different competence backgrounds. Their purpose is to connect people with shared interests in a certain domain. Examples are the Mobile Network and

the "SIG" community for the Flash program. They are only fairly formalised and may be both intra- and inter-organisational. They may also be dispersed geographically. Communication takes place both face-to-face and virtually.

Interest groups are loosely connected and very informal. Their purpose is to share ideas and experiences concerning a certain common area of interest. Examples of intra-organisational interest groups are Games Development and e-Learning. An example of an inter-organisational interest group is the Special Interest Group on Computer-Human Interaction (SIGCHI). Members represent different competence areas. They do not generally share the same physical space. Communication takes place both face-to-face and virtually.

Personal networks are emergent and usually invisible to others. They are informal. Examples of these are advice, idea generation, problem-solving, and cooperation networks. They are based on social relationships between people and are usually formed on the basis of experience of former working relationships. They may involve members from one or more competence areas. They may be either intra- or inter-organisational. Communication takes place both face-to-face and virtually.

Type 3: Meeting spaces

Physical, face-to-face forums, virtual meeting forums, and ad hoc spaces for interaction are based on the dimension of physical or virtual proximity.

Knowledge-sharing forums are physical or virtual. Their purpose is to share knowledge and experience with others. They are intra-organisational. Physical ones are fairly formalised and follow a pre-designed concept. Examples of these are Friday Infos, Fast Breaks, and Satama Opens. They involve members from all competence centres. Members share the same physical space, and communication is always face-to-face. Virtual meeting places involve discussion folders in Outlook, and communication is virtual. Some of them are accessible only to certain groups, while some are open to everyone. Some are accessible for all offices. These are not frequently used. In one of the smaller offices, there is an Intranet, which is frequently used for communication, even though the members share the same physical space.

Meeting spaces are either physical or virtual. The spaces are for ad hoc discussions on matters of mutual interest, knowledge sharing, and for discussions on problems and ideas. Physical meeting spaces include hallways and corners, the coffee machine, a special meeting room, and the cafeteria. In the main office, the cafeteria in particular is an important space to connect people and form relationships. Virtual meeting spaces were mainly discussion folders in Outlook. Additionally, one smaller office has an active Intranet discussion space. Both types of space are informal and intra-organisational. They may involve members from one or more competence areas. There were also inter-organisational meeting spaces.

Type 4: Inter-organisational structures

Professional associations are inter-organisational and fairly formalised. Members do not share the same physical space and communication takes place both face-to-face and virtually.

Partner networks involve partners working for the same client or working as sub-contractors on a project. Examples of members in partner networks are advertising companies and technology consultants. Networks are inter-organisational and fairly formal. Their members do not share the same physical space. Communication takes place both face-to-face and virtually.

Inter-organisational networks involve members from various organisations. They are dispersed and communication takes place mainly on a virtual basis. They may share an interest in a certain domain, such as mobile issues, or they may share the same background, such as the Satama Alumni. Meetings of the Alumni take place irregularly and bring together both present and former Satama workers.

Type 5: Social networks not related to work issues

Additionally, there are social networks that are not related to work issues, but take place within the context of the company. They serve to help people to get to know the people they work with and, in that way, enhance communication and interaction.

Social networks involve activities outside work. There is a formalised core group, 'Body and Soul', that is responsible for organising social events. It is intra-organisational and involves members from different competence areas. Their target group is the whole staff, though the activities basically take place in the main office. Members share the same physical space and communication takes place mainly face-to-face.

Besides the formalised group, there are emergent social networks, which involve people from various competence areas. Activities involve, for example, sports and bands. Communication is face-to-face.

All the sixteen formal, quasi-informal, and informal social structures were analysed using five dimensions and their three categories. Table 1 shows that social structures were mostly fairly formalised through having regular meetings. This is partly due to the fact that the organised ones are more easily recognised. The most informal ones often remain invisible to others and this makes it difficult to identify them. A social network analysis (e.g. Scott, 1991) would be an appropriate method to detect the most informal, invisible networks that exist in the organisation. Members were mostly from the case company, though there were also members from other organisations; they involved members from more than one competence centre, most members came from the same location, and communication took place both face-to-face and virtually.

Dimension	Level	Frequency	Remarks
Formality	+	3	
	+ +	9	Mostly fairly formalised or informal
	+ + +	4	
Organisational boundaries	+	8	Both intra- and inter-organisational
	+ +	5	
	+ + +	3	
Competence diversity	+	3	
	+ +	9	Mostly across competence boundaries
	+ + +	3	
Space	+	4	
	+ +	9	Most members share the same physical location, but office boundaries are shared as well to some extent
	+ + +	3	
Interaction	+	3	
	+ +	11	Communication both face-to-face and virtual
	+ + +	2	

Table 1: The characterisation of sixteen formal, informal, and quasi-informal social structures in the case company.

Discussion

The study shows the great variety of formal, informal, and quasi-informal social structures that are used for knowledge sharing in the case company. In fact, the number of formal structures is smaller than the number of informal ones. Their analysis in five dimensions shows their great heterogeneity as well.

Knowledge management in the case company is based primarily on the personalisation strategy (Hansen et al., 1999). Formal knowledge-sharing practices are based on face-to-face communication. In informal communication too, the personalisation strategy and face-to-face communication are valued more than virtual communication via ICT tools. The level of activity in the use of the Intranet and Outlook folders varies, but generally is not very high. In one small office, where people are physically close to each other, which promotes informal and spontaneous communication, the internal Intranet is also more actively used than in the other offices.

The social structures found in Satama Interactive correspond to those shown in literature. Lave and Wenger (1991), Wenger (1998), and Wenger et al. (2002) refer to communities of practice as informal, voluntary, and self-managed, with a shared domain and practice and a sense of a community. They may also be

invisible to others than those who are participating. The type that corresponds most closely to these concepts is the cross-competence SIG community. It is self-managed, with a co-ordinator, and membership is voluntary and based on the members' passion for developing the shared domain and practice within it. The elements of the community need to be studied more deeply. There are potential communities in this sense and also networks of people communicating in shared domains. These network communities are emergent and very informal. One possible explanation for the great variety is that the communities are in different phases of their life cycles. A group may start with a loose structure but the level of formalisation may increase with time.

Botkin (1999) and Storck and Hill (2000) refer to more formalised communities that focus on strategic issues. These types of communities, strategic communities, were also intentionally created at Satama Interactive. Their functionality and outcomes require further research, as they are still developing, but there is potential for viewing them as supported, institutionalised communities that enhance knowledge sharing at Satama Interactive. They also have characteristics that correspond to the concepts of Wenger (1998) and Wenger et al. (2002), such as shared domain and practice. The sense of a community needs to develop.

The types of communities defined by Andriessen et al. (2002) can also be recognised at Satama Interactive. Formal expert communities correspond to Satama's Formal Professional communities, such as Project Manager communities, who do not work together on a daily basis, but share the same expertise and are dispersed. Daily practice communities were not emphasised at Satama Interactive. Peer groups working in physical proximity with mainly face-to-face communication correspond most closely to these. What Andriessen et al. call informal network communities are more like networks and potential communities, rather than defined as communities according to Wenger (1998). Large problem-solving communities were not found at Satama Interactive. Problem-solving was based more on personal networks which were not recognised or visible to others. Email lists for problem-solving were mentioned by some respondents, but they were not organised, functioning rather on an ad hoc basis. Problem-solving, idea generation, and advice were based on personal relationships and experience of who knows what. These relationships correspond to what Krackhardt and Hanson (1993) found in their studies. A common feature of personal networks was that they were based on informal relationships that were not based on formal organisational boundaries but rather on previous working and project relationships. Yet there was a shared interest. In this way, they are similar to communities, but they are more like sets of relationships (Wenger et al., 2002), and they are loosely connected. The boundaries of these networks are also constantly evolving.

There is a great deal of informal communication at Satama Interactive. Even though there are various formal meetings, people still have a need to connect with others informally. Nonaka and Konno (1998) refer to physical, virtual, and mental spaces, or ba. Mental spaces were not studied, but both physical and virtual spaces exist at Satama Interactive. Physical spaces can be referred to as "enabling communication spaces". In particular, the lunch room in the main office was the space where relationships and potential emergent communities were built. The coffee machine in the cafeteria was referred to as "a physical hub" by one respondent. In one foreign office, there was a special meeting room for informal communication. As work at Satama Interactive is creative, a lot of informal communication seems to take place in "hallways and corners". All in all, the forms and variety of social structures are varied.

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Intranets and Local Community: 'Yes, an intranet is all very well, but do we still get free beer and a barbeque?'

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Abstract. This paper arises from a three year research project examining the development and implementation of a residential community intranet in Melbourne, Australia. At the time of writing, the level of use of the intranet by residents is low, and the paper explores possible reasons why this may be the case. These reasons include: a) the possibility that the aggregation of potential users and content is not appropriate; b) the possibility that the technology is not appropriate; c) the possibility that the conception of community relations on which the intranet is premised is not appropriate; d) the possibility that residents' perception of efforts to engineer community relations is not appropriate; and e) the possibility that the identity of the intranet as a domestic artefact has not yet been recognised by the residents. A consideration of these five possibilities using the specific case study raises issues concerning both particular community intranets, and more general socio-technical relations.

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Introduction

This paper examines the low uptake of an Australian community intranet called THE RANGE in its first year of operation. One year on from it's initial launch in March 2002, there has been negligible site activity. In this paper we construct an argument that draws upon and circulates through information systems and sociological perspectives to account for this underwhelming response. Our account involves an exploration of five questions that we believe are important to understanding this case, and community intranet technologies in other locations.

First, assuming that the technical characteristics of the community intranet are, in principle, capable of facilitating social interaction, what is required of the community intranet as a social entity? In particular, what is an appropriate level of social *aggregation* for a community intranet if it is to achieve a critical mass of uptake and use?

Secondly, assuming that the residents value traditional community norms and will seek to express those norms through whatever socio-technical resources are available to them, what *technical* characteristics of a community intranet are required for it to serve as a convivial medium for the expression of traditional community ties?

Thirdly, assuming that the requirements of a community intranet as a social entity are met, what *forms of community* are shaped by the performance of a community intranet? In particular, is it useful to an understanding of community intranets to distinguish between communities as collectives and communities as networks?

Fourthly, the community intranet is where software engineering meets social relations. Is there a possible *resistance to social engineering* of this sort amongst the residents of our case study?

Finally, the *appropriation and domestication* of any new technology requires that people 'recognise' the system. That is, in order to domesticate the system, residents need to attribute a distinguishing identity and function to the technology. Has the intranet been 'recognised' and 'identified' as a useful domestic artefact?

In the following sections of this paper, we expand on each of these questions and formulate a response that attempts to account for the underwhelming uptake of THE RANGE community intranet in its first year of operation. Each question and its implicit hypotheses is grounded in a different theoretical perspective that makes different assumptions about community intranet technologies, and about the nature of social relations. Each offers a partial account of the phenomena. From the formulations of these accounts, we conclude by proposing a model of community intranet adoption (or lack thereof) that integrates the relationship between these five partial accounts.

THE RANGE

THE RANGE community intranet is located in Williamstown; an established beach-side suburb close to the centre of Melbourne. Williamstown residents, many from families who have lived in the suburb for several generations, have a keen sense of local identity and community and often describing Williamstown as a 'village', or a 'country town', within a city.

At the time of its official launch in March 2002, THE RANGE was only accessible by residents of 51 newly constructed houses in Williams Bay, a housing development situated on the Rifle Range estate in Williamstown. Williams Bay was built by THE STONEHENGE GROUP (STONEHENGE), a medium sized property development and residential construction company who proposed the idea for a community intranet in 1998. Important in their plans was a vision that residential development needed to be about more than merely subdividing land and building houses: it was also about building community. STONEHENGE had a clearly articulated and positive view of the significance of community intranets for helping to transform residential developments into vibrant communities, and it acted on this view in a full-blooded way (Arnold 2003).

Functionality on the intranet includes: community news (from local groups such as the football club and environmental groups), message boards, notices of upcoming events, links to the local council, local classified advertising, newsletters (to be generated by local groups), a general calendar of local events, specific calendars of events for local groups, collections of documents (e.g. those generated by council activities), and so on. This vision of the central place of an intranet is now standard in commercial contexts, but is a novel innovation for residential developments in Australia.

One month after its initial launch, the zone of intranet inclusion was expanded to include the whole of the Rifle Range estate. The expansion doubled the population of the fledgling intranet community to nearly 100 registered households. Membership however, does not equal activity, and thus far the site has seen less than expected online participation. A Community Advisory Committee (CAC) had been formed some months earlier to be a 'focus group' that would deal with both the practical and theoretical concerns of the intranet. Consisting of both residents and STONEHENGE members, the CAC found itself more than once debating what should be done about raising activity – and thus perceived success – on the community intranet.

On the face of it there is good reason to be optimistic about THE RANGE'S prospects for success. The residents of Williams Bay and the Rifle Range are generally well-educated, middle-class and typically have professional careers as what might be called 'symbolic analysts' (Reich 1991) and thus should be 'natural matches for online communities' (Rheingold 2000, 46). Most residents are well accustomed to using information technology. They routinely use the

World-Wide-Web and e-mail in their work, and are able to use THE RANGE without having to climb a steep learning curve to do so.

In addition, the Williams Bay residential development was advertised and sold, in part, on the basis of the technology. At a series of social functions and meetings organised by the developer, and through qualitative interviews undertaken by project researchers, residents have indicated that community relations are important to them and they have expressed a generally positive view of the role THE RANGE can play in fostering their local community. The residential developer has taken the initiative to design, install, promote, maintain and subsidise the communications hardware, and the intranet software is a proven product, displaying all the contemporary features and functionality one might expect. Finally, while Williams Bay is a new housing development, it is located within a suburb with a long and strong history of community interaction and community identity. In all of the above, THE RANGE clearly meets the criteria for successful community development using information technology suggested in Pigg's (2001) review of community information networks.

However, THE RANGE has been online and operational since March 2002, and at the time of writing, traffic volumes are low, interactions are concentrated among a handful of residents, and residents have taken few initiatives to commence online discussions, post announcements, form groups, establish their own newsletters and so on. Most of the functional capacity of the system remains under-utilised, especially the capacity for residents to customise and shape the system to suit their own purposes. For example, 'Groups' provides functionality that gives interest groups an online presence. It allows members to communicate details of meetings, events, contact lists, documents, message boards and the like. At the time of writing, THE RANGE had 36 groups listed, under categories such as arts, sporting, children, environmental, recreation and resident groups. Of the 36 listed groups, 19 of these (53%) listed 0 members; five groups (14%) contain 1 member; one group has 2 members; three groups have 3 members; one group has 4 members; and one group has 5 members. In most cases these small groups are composed of STONEHENGE and CAC members, and have been established to 'kick start' intranet use. Of the 36 groups, only six groups (17%) have 6 or more members. Of these six groups, two are large resident groups, the members of which are automatically joined to one or the other upon registration, depending on where in Williamstown they reside; one is administrative; one is for the governing body of the annual Williamstown Festival; and the remaining two groups are for stay-at-home mothers and babysitting.

The Groups function is not alone in its under-utilisation. Similar levels of use (or non-use) can be witnessed in sections such as Neighbourhood Messages, Classifieds, Calendars and Surveys, all of which rely on resident postings and replies for their content.

Theory One: Aggregation and Critical Mass

> Assuming that the technical characteristics of the community intranet are, in principle, capable of facilitating social interaction, what is required of the community intranet as a social entity? In particular, what is an appropriate level of social *aggregation* for a community intranet?

There are arguments to be made that, as a social aggregation, the pool of residents in our case (thus far, less than 100 households) is too small to generate a self-sustaining 'critical mass' of interaction. Damsgaard and Scheepers (2000) emphasise the significance of critical mass to intranet institutionalisation. Mahler and Rogers (1999) argue that critical mass is particularly important in the adoption of technologies that are interactive, because of their 'strong network externalities'. This model, also referred to as a 'network effect' (Kelly 1994), or an 'accelerating production function' (Markus 1990), implies that increased numbers of users increases the value of adoption for both new and existing users, such that the adoption decisions of individuals depend heavily on the perceived numbers of others who have also adopted. 'This suggests that, in many situations, the diffusion of an interactive medium in a community may well be an "all or nothing" affair' (Markus 1990, 199).

In an attempt to build upon this work, we suggest that aggregation is important in achieving a critical mass. That is, achieving critical mass is contingent in a necessary but not sufficient way upon appropriate aggregation.

The term 'aggregation' is used here to refer to a metaphorical boundary that might be drawn at the perimeter of the intranet to indicate its zone of inclusion and exclusion, and it has both qualitative and quantitative elements. In quantitative terms, if the boundaries are drawn too tightly, and the zone of inclusion is too small, critical mass will be deficient. If too large (e.g. the Internet as a whole), the boundary is meaningless or arbitrary, and other unstable dynamics will result, such as fragmentation and/or a churning of participation in parallel with a rejection of the mode of communication. We suggest that aggregation also must be appropriate qualitatively. That is, the intranet boundaries must be drawn around users and content along 'natural' community fault lines that distinguish collectives, groupings and institutions that exist independent of the intranet. The structure of the intranet must faithfully reflect and resonate with the social alliances and divisions of its constituents. In organizational and community contexts, an appropriate aggregation to produce and sustain critical mass will thus have appropriate numbers, and appropriate social coherence.

In the context of community intranets these qualitative and quantitative dimensions of aggregation apply to users and their use of the intranet, and to the informational content of the intranet and the functions performed – referred to by Fulk *et al* (1996) as the public goods 'connectivity' and 'communality' respectively. So, the quantitative aggregation of connectivity takes into account

the number of people granted access, the number of people who exercise these access rights, their frequency of access, and the number of people who post messages or initiate other activity. The quantitative aggregation of communality includes the quantity of published documents at any given time and the quantity of document throughput in any given time period. The qualitative aspects of connectivity include the extent to which the intranet reflects the 'natural' social, political, commercial, organisational and cultural boundaries that define aggregations of users and their use, and the extent to which the intranet reflects the characteristics of groups of users and their differential propensity to access, and to post. The intranet may thus bound smaller groupings of more active users and larger groupings of less active users. Finally, qualitative aspects of communality as an intranet based public good take account of the significance of the content to potential users, the services it offers, the way the system handles the epistemological and ontological structure of the content's knowledge domain, the interface's structuring, linking and boundary drawing in relation to content, and its implications for usability.

The suggestion is that although people may wish to express traditional community relations, and although the intranet may be a convivial media for this expression, inappropriate aggregation has resulted in the absence of a critical mass of users and content, and thus a shortfall of traffic and intranet functionality.

Empirical support for this suggestion may be found in the differences in aggregation between reportedly successful community intranets, such as the Blacksburg Electronic Village (BEV) (Kavanaugh 1999, Kavanaugh and Patterson 2001, 2002), and THE RANGE. In quantitative terms, the BEV serves more than 17,000 members, whereas THE RANGE serves 51 households in Williams Bay plus a small number of Rifle Range households. On start up, the BEV was the only ISP in town, and more than 45% of the town of Blacksburg has access to the BEV, whereas a tiny proportion of the suburb of Williamstown has access to THE RANGE, and a still smaller proportion of the surrounding municipal council of Hobson's Bay. In qualitative terms, 85% of those with access to the BEV are affiliated with Virginia Tech., adding another dimension to the commonality of the aggregate. Reflecting the above, qualitative measures of user access to the BEV indicated a 1000 fold increase from 1994 to 1996, whereas use of THE RANGE has not yet taken off. In terms of aggregates of content and functionality, all 20 public schools have a BEV presence, as do 14 community newsgroups, 100 community groups, 200 local businesses and 150 non-profit organizations. Thus far the institutional nodes of local community interaction – schools, sporting clubs, service clubs and the like – do not yet occupy a prominent place on THE RANGE, and have not yet enlisted the intranet as a resource to support their activities, although both the BEV and THE RANGE allow community groups, businesses and individuals to develop and structure their content and interactions around this or that group, this or that event, this or that issue, in situ.

Important in all of this is the temporal dimension. Achieving critical mass is a process that is clearly time sensitive, and it might well be argued that in this case it is simply too early to have reached this threshold. We have no argument with this, and we note the continuing work of THE RANGE'S Community Advisory Committee (CAC) to increase users, use, and quality and quantity of content – clear examples of an attempt to achieve appropriate aggregation. The CAC has increased the pool of potential users, first from Williams Bay to the Rifle Range, and at the time of writing, efforts are underway to expand further to include the whole of the suburb of Williamstown, reflected in a name change to MYWILLIAMSTOWN. The CAC is also trying to increase intranet usage through promotional activities and by increasing content. More documents are being published, more traders and services listed, and more groups are made available to join. Attempts are being made to increase the quality of the site and to identify 'natural fault lines' within the surrounding area that can be exploited to make the site qualitatively relevant to a larger quantity of potential members. At the time of writing, a marketing push is to occur at the annual Williamstown Festival. In qualitative and quantitative terms therefore, the CAC is actively trying to re-work the aggregation in the hope of creating the critical mass required to overcome its current existential crisis.

Theory Two: Inappropriate Technology

> Assuming that residents value traditional community norms and will seek to express those norms through whatever socio-technical resources are available to them, what *technical* characteristics of a community intranet are required for it to serve as a convivial medium for the expression of community ties?

The residents at Williams Bay recognize the benefits associated with community and community values and espouse a desire for a tight-knit neighbourhood community. Throughout the early development phases, interest from residents was strong and many saw positive potential for the intranet to enhance their experience of community in the neighbourhood. Indeed, after a number of delays, some residents became quite impatient for the intranet to be delivered as promised. Against this background, it could be argued that the low uptake of the community intranet is a rejection of the technology itself. That is, community interaction is valued and is pursued in Williams Bay as it is elsewhere, whilst avoiding the intranet. If the intranet is capable of sustaining and/or enhancing community interaction, it would be used. It isn't, so it is not. Why not?

As an example of community intranet software, THE RANGE is state-of-the-art. It is easy to use, robust, customisable, and provides a comprehensive range of functions. However, the intranet as a mode of communication, as opposed to THE RANGE as an application, may not be appropriate for its intended purpose. For

example, much social interaction, particularly of the kind one might find on a street corner or at the supermarket, is banal, casual, spontaneous, flippant and disposable. Its strength and significance in the social sense, and its importance in establishing and maintaining social capital through weak-links (Granovetter 1973, Putnam 2000), is by no means diminished by the 'shallowness' of the content. Small talk is the important stuff of routine social connection, but is it the stuff we want to signoff on, and have posted in a public place available to all of our neighbours for an indeterminate period of time? Anonymous postings to THE RANGE are not accepted, perhaps a sensible rule in this context. However, the absence of anonymity may have the effect of increasing the responsibility that needs to be exercised by posters to a degree that is inappropriate for the social nature of the exchange.

In addition, lack of spontaneity in online interactions may also be a factor that could account for the rejection of the intranet as a convivial medium for sustaining neighbourhood community interaction. To go to the intranet, logon, navigate to a specific location, read the postings, compose a new posting, type, edit and redraft the posting, then signoff on it and hit the submit button, then to be publicly associated with the posting, accountable for it, and known to many other people by these postings, all requires a degree of deliberation that cuts across the very character of neighbourly small talk.

These factors work against the establishment of private discourse between individuals, and limit the opportunity in the online environment for engaging in important community building activities, such as gossip and ephemeral banter. Unlike on the footpath, one doesn't bump into a neighbour, recognise her as a local without knowing her name, and stop to pass the time of day. The abstract 'calculative' nature of text as a communication media and the structured, arboreal and hierarchical arrangement of postings and replies are other factors that would seem, from this perspective, to work against intranet technology acting as a convivial mode for the expression of neighbourhood community ties. While much online communication of this kind has been characterised as 'conversational' (Rheingold 2000), these characteristics of online communication may work against the kinds of spontaneous, ephemeral, and unstructured conversations that neighbours engage in as they build a local community.

And yet, there would appear to be clear existence-proof of successful social interaction and community formation, in terms determined by participants, that is entirely electronically mediated (Kavanaugh and Patterson 2001, Rheingold 2000, Turkle 1995, Wellman and Gulia 1999). What then, are the characteristics of successful use of this mode of communication for social interaction?

Firstly, there are communities of interest that make successful use of listserv, bulletin board and similar electronic forums to sustain ongoing discussion. In these cases, interaction typically occurs around a focused and defined topic of interest; and staying on topic is an aspect that is often closely policed by

participants (Phillips 1996). Postings have permanency, are public, and are often archived as a repository of collective wisdom. The group may thus be regarded as a 'learning community' or virtual 'community of practice' (Brown and Duguid 1991, Wenger 1998). A neighbourhood community intranet displays some aspects of this mode of interaction, and the intranet software is able to support focused groups, but the community intranet as a whole clearly has a different mission to the focused interest group.

Secondly, electronic communities may make successful use of 'chat-rooms', Multi-User Dungeons (MUDs) and the like. In these cases interaction is not focused, perhaps to the point of banality. These interactions are essentially ephemeral, in that they are only readily available to those virtually present at the time of posting, and thus encourage/support spontaneous trivial discussions (gossip) that are 'of the moment' and are the building blocks of community interaction. A neighbourhood community intranet also displays some aspects of this mode for interaction, but a residential community and its intranet clearly has a sense of permanence and a located sense of purpose not reflected in a typical chat-room or MUD.

Both kinds of virtual community rely on a very large pool of potential contributors. Communities of interest seek to find the small subset of people with a specific interest in common, and MUDs rely on a large enough pool of participants for there to be a high probability of there being someone online to engage with when one is also online. In neither case is neighbourhood important. Indeed, the appeal of the technology in these examples is the irrelevance of distance and the possibilities created by the technology to interact with people that one is unlikely to ever meet face-to-face. These examples stand in stark contrast to THE RANGE where the pool of contributors is small, their commonality is geographical and not interest-based, and encountering each other off-line is a highly likely occurrence.

Thirdly, there are the cases of intranet technologies that have been successful in geographically located community settings (for example, Netville, BEV, Amsterdam's DDS) that point to a clear need for further research to identify salient factors that distinguish the experience of these cases from THE RANGE.

The title of this paper is drawn from a comment made by a resident at one of a series 'town-meetings' hosted by the developer to discuss and promote the intranet. All residents were invited to these meetings, which usually involved the provision of food and drink. The most popular meetings were held on weekend afternoons and involved spit-roast barbeques and ample supplies of alcohol. Many residents found these events to be a significant means of meeting their neighbours, and they have become social gatherings that residents value. The comment – 'Yes, an intranet is all very well, but do we still get free beer and a barbeque?' – expressed a concern over the community building value of the intranet in-and-of itself, versus the community building value of the face-to-face

social gatherings that were part of the process of creating the intranet. Ironically, despite the low uptake of the technology itself, the process of soliciting support for it, and attempting to gather resident's design requirements, has encouraged residential interaction and helped promote community formation.

Theory Three: Forms of Community

> Assuming that the requirements of a community intranet as a social entity are met, what *forms of community* are shaped by the performance of a community intranet? In particular, is it useful to an understanding of community intranets to distinguish between communities as collectives and communities as networks?

To value community is normative, and many people are distressed about what they see as a loss of community and community values. Putnam (2000) and Etzioni (1995) are among many to use empirical and anecdotal evidence to argue the continuing collective and individual value of community. Putnam (2000) for example, provides exhaustive empirical data to suggest that in the United States strong communities, characterised by dense networks of weak links, are associated with a variety of positive outcomes including: better educational outcomes for children; reduced criminality and a greater sense of personal security; wider job and business opportunities; improved health; better governance, and more efficient and effective use of public and private resources.

Community interactions occur in the context of built environments or infrastructures that are in part ancient – towns and villages, pathways and their intersections, doorways and porches, parks, markets and village squares and the like – and are in part new – telephones, freeways, email, aeroplanes, and so on (Wertheim 1999, Dodge and Kitchin 2001, Kitchin and Blades 2001). Like all contexts, the characteristics of this environment or infrastructure in any given case, facilitate certain modes and forms of interaction, whilst discouraging others. THE RANGE community intranet anticipates and seeks to facilitate community interactions between geographically proximate individuals and groups.

Support is widespread for the view that place, propinquity or locale remain significant contingencies in the conduct of social, economic and community relations. Whereas space (i.e. distance) may well have been progressively erased by modernist and contemporary transport and communications technologies (at least for some), this should not be confused with an erasure of place. In economic and cultural terms Paris, New York, Mumbai, London remain important centres; as they have been for hundreds of years (Graeme and Marvin 1996, Castells 1997). In terms of an individual's social relations – including community relations – place also attracts significant support. Walmsley (2000) for example, argues that there are a dozen reasons to reject the 'end of geography thesis':

information is only actionable in a situated context; much use of CMC is to facilitate face-to-face meetings; place is a significant site for consumption and is a consumer item in its own right. He concludes that 'place and local community are, and will continue to be, fundamental to the functioning of society' (2000, 17).

Support for the view that an intranet is capable of fostering traditional community interactions can be found in a number of case studies, the Blacksburg Electronic Village (BEV) and Toronto's Netville being the best known. In Blacksburg, research indicates that 'computer networks are not just reinforcing – but even expanding – existing social networks within an existing geographic community' (Kavanaugh 1999, 2). Kavanaugh and Patterson report 'frequent and increasing use of the BEV and Internet for local, social-capital-building activities' (2001, 496). Wellman, although foremost in developing the network model, acknowledges that distance still matters. The empirical evidence from the East Yorkers of Toronto reports that 22% of all active social ties are with people living within one mile of the informant, and 42% of frequent active social ties (face to face or telephone communication three times per week or more) are with people living within one mile of the informant (Wellman 1996). Hampton and Wellman report that in Netville, 'contrary to expectation that the Internet encourages a global village those ties that previously were just out of reach geographically experience the greatest increase in contact and support' (2001, 476). It was found that on average those who are online know 25 neighbours; the unwired know only eight. Moreover, the ties of those online range farther through the neighbourhood instead of clustering on the same block (Wellman and Hampton 2000). Wired homes in Netville are over three and a half times more connected in terms of talking to one another, compared to non-wired homes (Hampton 2003).

However, as Wellman (1988) argues, the Töennian notion of a located *Gemeinschaft* community may be outmoded in the current era, if indeed it was ever an appropriate analysis of this form of social interaction. The notion of a geographically based community constituted in broadly based common interests and obligations, and shared 'third spaces', might need to give over to a different construction of the relations between non-intimates.

In this new 'ego-based' or 'network' construction, social relations between non-intimates are private assets, built and maintained by individuals to serve their particular assemblage of social interests. A person's portfolio of non-intimate social relations may include acquaintances with shared sporting interests, work colleagues, others from whom one borrows tools, others with children of the same age, and so on (Wellman 1988). These geographically extensive ego-based social networks bear little relation to Tönnes' *Gemeinschaft*, and are not rooted in shared place.

From this perspective, it can be hypothesised that the Internet is well suited to the above ego-based model, but local community intranets, such as THE RANGE, are not. On the one hand, local community intranets are placed-based, while ego-

based relations are not. Although a traditional view locates community geographically, communications and transport technologies have significantly weakened whatever relevance geography might have had to community. People value community relations but ego-based communities have nothing much to do with where one lives, and nothing much to do with a place-based network. Therefore, local community intranets which privilege and attempt to define, bound and ground relationships within a place-based geography are working on the wrong assumptions about social relations and are doomed to failure. On the other hand, the Internet is not place-based but is arborescent and global (Ostwald 1997). As such, it provides a vast pool of people from which relations may be built and maintained. Such a pool vastly extends one's reach in building an ego-based network and is particularly useful for finding a close fit of interests with other individuals.

If this hypothesis is accepted, the notion of an intranet based on a grouping of neighbours is fundamentally flawed. And this 'network model' of social relations does resonate with much of our experience of contemporary life. As Wellman (1988) points out, the population is mobile; in a day to day sense, and through a lifetime. At any one time, friends, family and work-associates are as likely to be on the other side of the world as they are to be on the other side of the street. Work has replaced neighbourhood as a point of social gravity. The community as a coherent and stable pastoral village has probably always been a myth. People are individualistic in the pursuit of their interests, and their social capital is a private accumulation to be found in each individual's Teledex and fast-dial numbers, rather than in their neighbourhoods.

Members of THE RANGE are characteristically well-educated, upper-middle class 'information workers' (Bell 1973) who move comfortably in 'the space of flows' (Castells 1997). They have money, careers, easily accessible transport and the ability to indulge in leisure activities. Personal 'portfolios' of social relations are extensive and widespread, and not limited by geography.

Such is the postmodern condition, but, as argued above, there are contradictory indications and existence-proof examples suggesting that locale remains significant. If nothing else, and regardless of communication and transport conveniences, locale remains a strong indicator of shared class, occupational groupings, income, age, political leaning and cultural values, which in turn imply shared subjectivities and shared objective interests. Our social relations may not be constrained by geography, but they are not blind to geography.

Theory Four: Social Engineering

The community intranet is where software engineering meets social relations. Is there a possible *resistance to social engineering* of this sort amongst the residents of our case study?

Social engineering, or a possible resistance thereto, is important to consider when examining reasons why systems such as community intranets are adopted or not, as the systems themselves are engineered forums intended to structure and host communities. In 'Seeing Like a State', Scott sets out to account for the logic behind failed schemes of social engineering in the past century, in particular, schemes that 'were animated by a genuine desire to improve the human condition – a desire with a fatal flaw' (1998, 342). THE RANGE fits this category, as it was developed and sold with a genuine utopic desire to improve the community and the social relations of its members. Given this desire, Scott's views on such forays into social engineering, inform our account of the low uptake of THE RANGE. Although the focus of Scott's work is state schemes, we find parallels between it and our private enterprise, community intranet that provides an interesting point of departure for exploration. He outlines four elements which, in combination, make for a full-fledged disaster of state-initiated social engineering. These four elements are: 1) The administrative ordering of nature and society; 2) A high-modernist ideology: a twentieth-century phenomenon in which entire social orders are engineered to adhere to often unrealistic utopic ideals; 3) An authoritarian state that is willing and able to use the full weight of its coercive power to bring these high-modernist designs into being; 4) A prostrate civil society that lacks the capacity to resist these plans (Scott 1998, 4-5).

In the example of THE RANGE, we can see that the administrative ordering of nature and society occurs through the intranet system itself, and its online subsets, functions, groups and categories that hope to order social interaction. As argued earlier, this mode of communication is structured, rather than unstructured, and requires deliberative rather than spontaneous forms of communication. A high-modernist ideology may be recognised in the vision of the Managing Director of STONEHENGE, who grew up in Williamstown, and wished to create something positive, innovative and long-lasting when putting forward the tender to develop the Williams Bay parcel of land. The Managing Director is a progressive 'who [has] come to power with a comprehensive critique of existing society and a popular mandate (at least initially) to transform it' (Scott 1998, 89) and he often cites 'lack of vision' and a 'woefully inadequate provision for future enhancement within the building industry' (STONEHENGE 1998, 5).

Scott's third element refers to the rule of an authoritarian state, and whilst we make no claim that this horror is reproduced, neither is an intranet a Habermassian public sphere. While residents are free to form groups, make postings and in other ways modify and control the system, the system administrator controls the system's basic structure down to the level of data definitions, interface designs, and all user privileges. No dictator exercises power over a domain as absolute as the systems administrator. Like all computer based systems, THE RANGE is structured, formatted, rule and procedure bound, and has a very defined visual aesthetic that immediately places its members within a higher

authoritative context. To post a message on a message board, members must enter all information into a formatting device. To see a calendar for a particular group, they must first make sure they are a member of that group so that they may be allowed access to its information. Entry into the site is user ID and password protected and anonymous postings are not possible. The community intranet is a constructed and extremely structured world; an embodiment of an authoritarian state and its respective technical, ideological and commercial engines writ small.

Finally, Scott's prostrate civil society can be seen in the residents themselves, both those who are signed-up members of the intranet and (just as importantly) those who are not members, but who nonetheless live in the designated geographic boundaries of inclusion. Interviews with residents have provided an almost universally positive response when asked the question of whether they *like* the idea of the community intranet. After all, who could not like and agree with anything that hopes to promote the values of community and society as a whole? To say that one dislikes the thought of the community intranet is akin to saying that one dislikes community itself. In this fashion, the residential members of the community intranet lack the capacity to resist the plans of the authoritarian state, as it is ideologically incorrect to naysay the notion of community.

While unable to naysay the notion of community and the community intranet, residents have exhibited an uneasy with the community intranet and have expressed an ambivalent relationship to it. While generally positive about the idea of a community intranet, residents also see THE RANGE as a curiosity; an oddity of sorts. Residents often speak of the 'funny reactions' from friends and relatives when told of the intranet they belong to. Comments such as 'how strange', 'what an odd idea', 'god, I'd never use it' and 'do you think it will last' all featured heavily in these reported conversations. The intranet is dealt with as a curiosity by others perhaps because it is seen as a curiosity by residents themselves. It is something not found within 'normal' life and 'normal' neighbourly relations. THE RANGE has been established from the top down, while more 'natural' communities are emergent phenomena and develop, as it were, 'bottom-up'. The residents' unease with the form of community relations inscribed in THE RANGE supports the theory that this particular type of social engineering is being passively resisted. The opening quote, 'Yes, an intranet is all very well, but do we still get free beer and a barbeque?' suggests that the familiar, emergent forms of community interaction are what residents of THE RANGE feel most comfortable with, not the engineered 'curiosity' of the current system.

Manuel Castells also has much to say about issues of governance and the formal structuring of community. In 'The Internet Galaxy', Castells (2001) describes a community intranet in Amsterdam: *De Digital Stade* (DDS). At first, DDS was an enormous success, described by Castells as 'the most famous citizen computer network [that] instantly became an extraordinary success in terms of its public appeal' (Castells 2001, 146). Following its initial success, there were many

requests for sponsorship, commercialisation and membership, so much so that what began as a ten week trial turned into an official foundation with a formal managerial structure. This formalisation coincided with the downturn of its popularity. Castells argues that he irony of DDS was that the formalized structure, created due to its initial success, led to its eventual failure (2001).

Building on Scott's work, it would seem that passive resistance to perceived attempts on the part of the systems developer to 'engineer' a community and to formalise its operation have contributed to the benign neglect of THE RANGE by residents.

Theory Five: Domestication of Technology

> The *appropriation and domestication* of any new technology requires that people 'recognise' the system. That is, in order to domesticate the system, residents need to attribute a distinguishing identity and function to the technology. Has the intranet been 'recognised' and 'identified' as a useful domestic artefact?

'Domestication' is a form of social learning, in which users find a way to incorporate an introduced technology into their lives (Williams *et al* 2000). New technologies are 'learnt' through both practice and interaction – 'learning by doing', and 'learning by interacting' (Williams *et al* 2000, 29). Through a process of negotiation and translation, practical local activity and local knowledge are utilised to position the relevance, use, and benefit of an introduced technology so that it 'fits' within the lives of its intended users.

Domestication is clearly a process, and any observation one might make is strongly contingent on the time of the observation. Nevertheless, an early and necessary stage is to recognise a new technology, often through a metaphor or an analogy, that acts to place the new and unusual in a more familiar context, such as the automobile as a 'horseless carriage', the television as 'radio with pictures', and the computer 'desktop'. When THE RANGE was expanded to include the whole of Williamstown in March 2003, residents were offered free registration as a way of enticing them to become members of the community intranet. Common responses were: 'Oh, I already have the Internet', or 'What is an intranet?', suggesting that recognition of intranet technology does not exist by default, and needs to be learnt. Residents need to construct an image of *what it is* before they will adopt and domesticate the technology.

However it is not just the residents who are required to participate in domesticating THE RANGE. The system implementers must also partake in the process. The transferral and application of local knowledge essential to domestication creates a 'learning economy' around new technologies, in which suppliers and users jointly interact to successfully appropriate the introduced

technology. It is through this mutual reciprocity that the technology becomes domesticated. Since the creation of THE RANGE, STONEHENGE has actively tried to familiarise residents with the intranet through a series of social functions, demonstrations and pamphlet distribution, in which the features and the benefits of the system have been promoted.

What THE RANGE *has*, and what THE RANGE *does* has been thoroughly explained. What THE RANGE *is* however, has been all but neglected, perhaps because the developers are approaching the task of eduction from a different perspective. The developers know what an intranet *is*, and to them, the concept of an intranet is self evident. When they present THE RANGE to residents, their approach is one of *features* and *functionality*, and not one of *identification*. While hearing about features and functionality may be interesting to potential users, the information is almost useless unless they have somewhere to either metaphorically or practically place this information. The technology of THE RANGE is 'domesticated' for the developers, yet remains 'wild' and 'elusive' for the residents. From a residents' perspective, THE RANGE has function without purpose, and is a solution without a problem. This ontological misalignment between resident and developer creates a 'chasm of misunderstanding' that must be addressed before recognition and domestication can occur.

Conclusion

It has been argued that five factors have the potential to contribute to the low rate of intranet uptake at Williams Bay. In short, these five factors are: inappropriate aggregation and an absence of critical mass; inappropriate technology for the purpose; a misreading of the shape of community relations; a passive resistance to social engineering; and inadequate recognition and domestication of the technology. No one will be startled by our first conclusion that all five factors have played a part, and that builders and students of intranets need to be mindful of the mix of each of these five factors in any given case.

Beyond this, it might also be concluded that all five factors are interrelated, and a number of points might be made in an effort to draw out the relations between the five, and their respective contributions.

We begin at the centre of Figure 1 by asserting that there is a relation between participation rates and critical mass. Whilst an absence of a critical mass of users and content clearly bears a relation to a low intranet participation rate, the two are not synonymous. A 'low participation rate' indicates an empirical observation, whereas an 'absence of critical mass' indicates an analytical construct that seeks to account for the former. The arrows connecting the two indicate a direct proximal cause. That is, the simplest and most immediate account for the empirical observation of low participation rates is provided by the critical mass analytical construct.

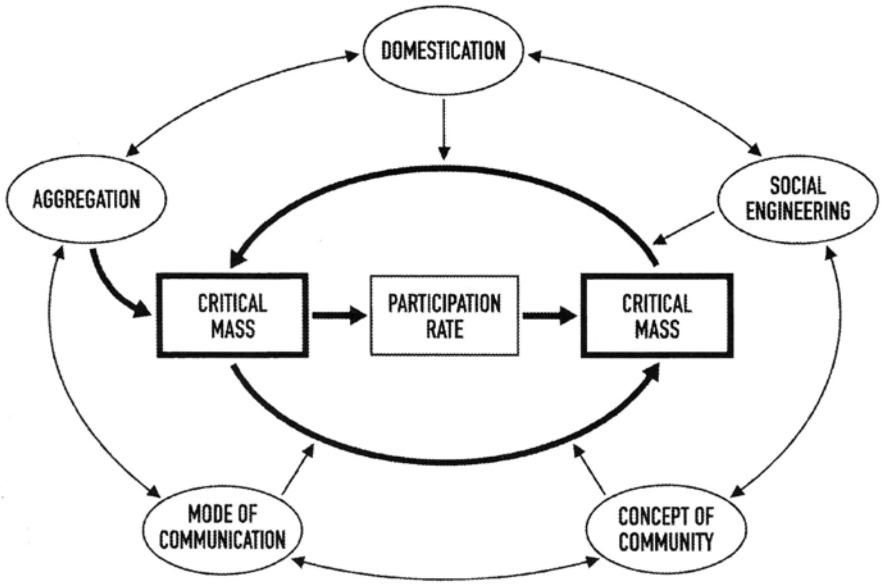

Figure 1

In our case study, whilst the absence of critical mass provides a theoretical account for the low participation rate, the low participation rate provides the empirical evidence by which an *a priori* judgment is made about critical mass. In essence, a quantum threshold is theorized, and participation rates are placed in relation to that threshold. Moving out from this immediate and direct relation is the loop of causality that leads *from* a critical mass of participation to a critical mass of participation. The identification of critical mass of participation as both a cause and effect of itself implies the existence of a self-fueling 'virtuous loop' of upwardly spiraling participation rates when critical mass is achieved, and a self-fueling 'degenerative loop' of downwardly spiraling participation rates when short of critical mass. If critical mass is never achieved, the loop may lock-in a low or negligible participation rate.

The next level of mediation is represented in Figure 1 by the radial arrows that connect inappropriate aggregation, passive resistance to social engineering, inappropriate concepts of community, inappropriate modes of communication, and inadequate domestication, to the critical mass spiral (and through to participation rate).

The diagram implies that each of these separately, and all of them together, influence the building of a critical mass of users, use and content, and thus participation. Different intranets will display different characteristics and operate within different environments, meaning that the relative influence of each of the five will vary. In the particular case of THE RANGE we have formed the opinion

that although all five factors contribute, inappropriate aggregation contributed the most, on the basis that aggregation of users was very distant from optimal.

Finally, and most removed from immediate causes of low participation, but in a sense at the root of these causes of low participation, is the reflexive relation between the five. The double-headed arrows indicate that in addition to an individual and collective influence on the critical mass spiral, each of the five factors contributes to the constitution of the others. Thus, the boundaries of inclusion and exclusion that define the characteristics of aggregation are reflected in the mode of communication (decisions made about who can and cannot do this or that on the intranet), which in turn informs a concept of what a community is and what it is not, which flows through to a recognition of an attempt to engineer a set of community practices and an inclination to embrace or resist that attempt, which ultimately implies inadequate recognition and domestication of the technology.

Or, we might begin with the concept of community held by developers or residents, and trace that through to the shape of the mode of communication (forged in intranet design and use decisions), which flows through to the patterns of inclusion and exclusion that define aggregation, and thus the engineered and undomesticated nature of the social project. It matters little where one starts the analysis – each would seem to be both input and output to the others, in a tangled web indeed.

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Learning and Collaboration across Generations in a Community

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Abstract. We report on the activities and outcomes of two workshops in which middle school students and senior citizens explored, designed, and constructed visual simulations related to community issues. The workshops are part of a larger project, in which we are studying the effects of community-related programming projects and discussion on residents' computer literacy and community involvement. We describe the interactions among participants of varying age, and the simulations that they designed and built. We also discuss the influence of age on participants' reactions to the workshop activities, and consider what implications these findings have for our goal of building and maintaining a cross-generation learning community.

Introduction

The increasing pervasiveness of community networks creates new opportunities for interaction and synergy within towns and cities (Carroll & Rosson; 2001; 2003; Cohill & Kavanaugh, 1997). Instead of attending a town council meeting, residents email questions or comments to town officials (Cohill & Kavanaugh, 1997). Elders who remember key historical events or perspectives share these in simple online forums (Carroll et al., 1999). Teachers who have traditionally worked autonomously within their own classrooms share their resources and strategies with other teachers using online tools (Kim et al., 2002). In this paper, we discuss another opportunity created by community networking—informal and collaborative learning among diverse segments of a local population.

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Our interest is in community members at two ends of the age spectrum: children and senior citizens. As Putnam (2002) has argued, a community's elders are a valuable resource, with the time, motivation, and wisdom to contribute to many community endeavors. In contrast, school children are energetic, curious, and comfortable with computing technology (Brown & Cole, 1997; Druin, 2002; Mayer et al., 1997; Lewis et al., 1997; Gilmore et al., 1995), but have little experience with community activities. For two years, we have conducted a community outreach project—COMMUNITYSIMS—under the premise that the assets and energies of the young and old can be synergized in a cross-generation learning community where members participate in a complementary fashion.

The goals of COMMUNITYSIMS are two-fold. First, we seek to engage members of our community in a shared learning and discussion process that enhances appreciation of community issues. Second, we hope to empower residents with new computing technology that they can use in raising and discussing these concerns (see also Arias et al., 2000). We are pursuing these goals by inviting young and elderly community members to build visual simulations that address community-related topics (e.g., noise pollution, bullying at school). The resulting simulations are shared and discussed more broadly in a community Web site.

Building a Cross-Generation Learning Community

Although our vision of a cross-generation learning community is attractive, pursuit of such a vision entrains many challenges. School children may interact with community elders as mentors on school projects (Gibson, et al., 1999; Oneill & Gomez, 1998), but they have no reason to seek their guidance outside of these teacher-guided school settings. Senior citizens are often highly motivated and active online constituencies in community networks (Carroll & Rosson, 1996; Carroll et al., 1999; Ellis & Bruckman, 2001), but sending email or visiting a web page is qualitatively different from designing or building visual simulations.

Studies of learning communities emphasize the role of authenticity in learning, where the concepts and processes of the learning situation are linked to those of the real world (Brown & Campione, 1994; Brown, Collins & Duguid, 1989; Lave & Wenger, 1991). Thus one aspect of the COMMUNITYSIMS vision is to link residents' learning and use of computing technology to the issues they face and address in their day-to-day lives. Researchers have also pointed to the benefits of diversity within a learning community—diversity may promote socio-cognitive conflict and discussion of alternative solutions (Foot et al., 1990); more knowledgeable individuals can serve as role models and guides (Bandura, 1977; 1986) while simultaneously reinforcing their own understandings (Lave & Wenger, 1991). However, if COMMUNITYSIMS is to form and nurture a cross-age learning community, we must first understand the varying motivations and learning potential of the young and the elderly community residents.

Our strategy thus far has been to combine detailed studies of children and elders as they learn to build visual simulations, with simulation workshops that explore residents' interest and success in cross-generation design and discussion. The first year of the project focused on the learning problems of different populations (Lewis et al., 2002; Rosson & Seals, 2001; Rosson et al., 2002; Seals et al., 2002; Wissman, 2002). The results of these studies have guided the design of self-paced tutorials customized for different age groups; these tutorials are now available for other community members wishing to participate in the project.

The current paper reports the result of two exploratory one-day workshops where children and elders worked together on simulation programming projects. One practical goal for the two workshops was to acquaint some of the children and elders we had been studying in the training sessions; we hoped that by facilitating this initial interaction between these two age groups we might seed longer term relationships. More importantly, we wanted to study the nature of the cross-generation collaborations that emerged, so that we could try to facilitate such interaction more broadly within the community.

In the balance of the paper, we first provide an overview of the workshops and participants. We next summarize the workshop activities, focusing on the interaction between the children and elders, and on their differing reactions to the the simulation projects. We conclude with reflections on the prospects for expanding these preliminary efforts to the community at large.

Workshop Overview

We wanted the workshops to be a friendly and supportive environment in which children and elders could meet and learn about one another, and collaborate on programming projects. Our research team was available to coach and answer questions as needed, so that participants did not feel that they were being "tested"; instead we encouraged them to have fun with a starting set of simulations and tools, and to explore and build their own ideas for community simulations.

STAGECAST CREATOR

COMMUNITYSIMS projects are built in STAGECAST CREATOR, a visual programming environment designed to allow children and other nonprogrammers to build simulations by example (Smith & Cypher, 1999). Users program simulations by creating a "stage" (a rectangular grid) of animated characters. Users create one or more visual appearances for each character, along with a set of rules that enable the characters to move, change appearance, create or delete other characters, and so on. Thus the effects of a simulation are experienced as visual animations in which characters appear, move, encounter one another, change shape or color, and so on.

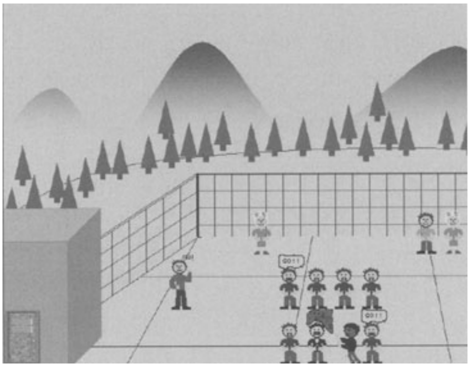

Figure 1: A schoolyard fight simulation built in STAGECAST CREATOR.

Figure 1 displays the stage of a COMMUNITYSIMS project—a schoolyard fight. The students and the teacher are characters, as is the door. The visual before-after rule in Figure 2 illustrates the basic visual programming paradigm: if the starting condition for a rule is met, the actions are performed. The starting condition specifies a visual context (the two boys next to each other, facing forward), though it may also specify values for variables defined globally or for each character. A key challenge in Creator programming is the mapping of simulation objects and behaviors onto visual effects (Seals et al., 2002; Smith & Cypher, 1999). For instance, in the schoolyard fight, changes in the "tension" variable cause the boys to begin pushing and hitting each other.

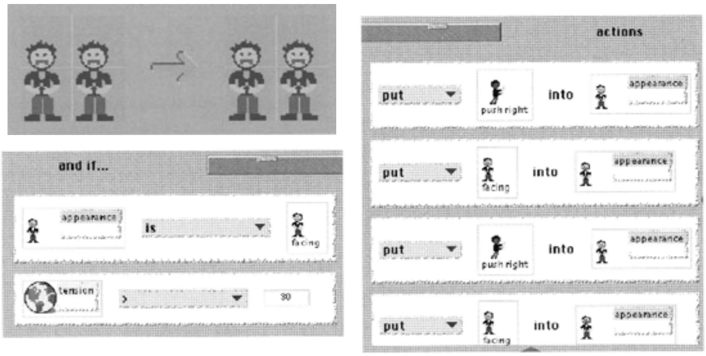

Figure 2: A rule specifying the when the pushing is to begin.

Workshop Participants

We recruited children and elders who had already received training in CREATOR programming, so that they could focus on the use and creation of simulations rather than introductory learning. The elders had received their training as part of

an experiment comparing the efficacy of two different tutorials (Wissman, 2002). Because this earlier work had suggested that older women find visual programming in CREATOR more interesting than older men, we decided to recruit only women for these first two workshops.

The children were middle school students who had been introduced to CREATOR during a formative evaluation of a minimalist tutorial (Seals et al., 2002). In order to minimize social awkwardness and distraction among the student participants, we decided to recruit only boys for the first workshop and only girls for the second. Three women and four boys came to the first workshop; one woman and three girls came to the second[1]. The participants were recruited through email messages or phone calls; each individual was offered a small stipend ($30) as a thank-you for coming to the one-day event.

As we expected, the boys and girls had more experience with computing than the women (Table 1): the students reported more years of computer use, and described a greater variety of computer-based activities, than the women. An important difference is the relative experience with "programming" activities, for example, the creation of spreadsheets or Web pages. The students had experience with graphics or drawing tools while none of the women had used such tools.

Background question	Women (N=4)	Boys (N=4)	Girls (N=3)
Years of computing?	5.25	7.50	9.00
Regular use of word processor?	3 of 4	4 of 4	3 of 3
Use of spreadsheets?	1 of 4	4 of 4	3 of 3
Use of drawing or graphics editors?	0 of 4	4 of 4	3 of 3
Experience building Web pages?	0 of 4	3 of 4	2 of 3

Table 1: Participant Background

Workshop Activities and Data Collection

The two workshops followed the same schedule and provided participants with the same materials and activities:

- Introduction to COMMUNITYSIMS; brief statements of personal interests and background with computing.
- Walkthrough of COMMUNITYSIMS Web site; practice logging on, opening, running, and commenting on existing simulations.
- Subjective reactions to sample simulations and simulation features.

[1] Two additional women were scheduled to participate in the second workshop, but last-minute personal problems prevented them from attending.

- Refresher tutorial on CREATOR; basic skills and advanced techniques.
- Group formation, each woman joined one or more students; due to absent participants, two girls were paired with researchers.
- Collaborative work extending 1-2 simulations.
- Collaborative generation of ideas for 1-2 new simulations.
- Collaborative construction of a new simulation.
- Survey of general reflections and project goals.

Throughout the day, the research team assisted attendees and took notes. We also recorded the discussion among participants. In the following three sections, we present observations and analyses based on several sources of data: the workshop transcripts, comments and changes to existing simulations, the new simulation projects, our informal notes, and responses from the two surveys. We first summarize the use of the Web site and the CREATOR tutorial; we then discuss cross-age collaboration and participants' reactions to the workshop.

Learning and Use of CREATOR

In the first part of the workshop, participants worked individually, first interacting with the COMMUNITYSIMS web site, then the STAGECAST CREATOR tool.

Exploring the COMMUNITYSMS Website

In the first year, our research project focused on creation of sample simulations and tutorial materials suitable for residents of differing ages (Wissman, 2002). We are now shifting our emphasis to sharing and discussion of the simulations, that is, to the building of an online community around the simulation projects. Thus one goal of the workshops was to introduce participants to our prototype Web site, so that they could explore the materials and tools it contained.

Figure 3 displays a screenshot of the welcome page the users encountered when first logging in (guests can also visit, but are unable to upload or download projects). The workshop participants spent approximately 30 minutes experimenting with seven example simulations (Table 2).

The women and students explored the website quite differently. The women were cautious in their navigation, bothered by problems such as system response delays and confusing controls for using the CREATOR simulations. In contrast, the students were quick to follow links and try things out, even without explicit guidance. If one simulation was too slow or seemed not to be working right, they simply moved on to another. As a result the students opened and explored more of the sample simulations than the women: all of the students contributed at least one comment to a simulation (one of the girls commented on five of the seven),

whereas only two of the four women did so. Nonetheless, all participants successfully accessed and used at least two of the sample simulations.

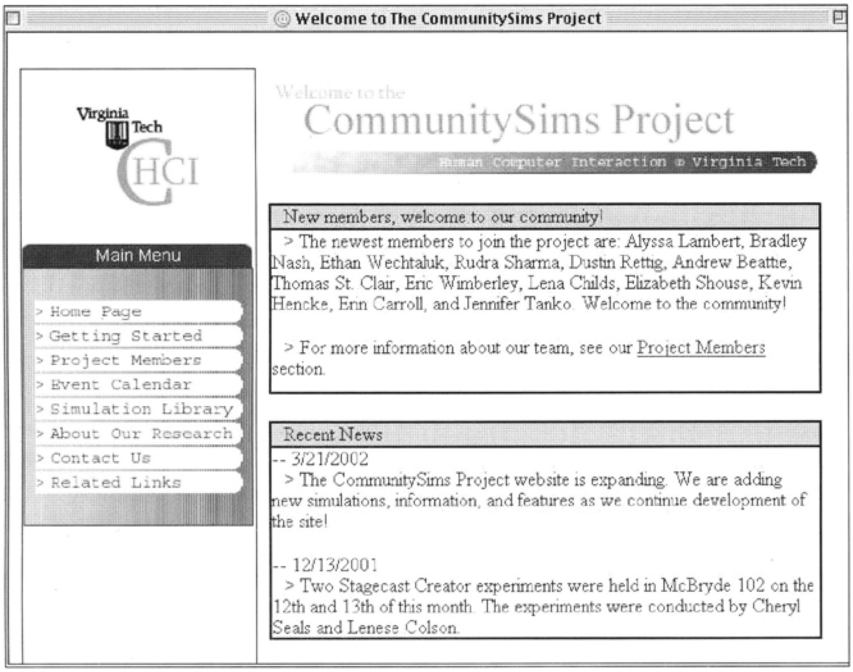

Figure 3: COMMUNITYSIMS home page.

Simulation	Description
Smoking Kids	Two kids smoke at school, get sick, collapse
Schoolyard Fight	Two kids argue, yell, eventually push and hurt each other; a teacher comes out and stops fight
Flirting or Hurting	A cute guy is rebuffed by one girl, but tries to force his attentions on another
Noise Pollution	Young people have a party with loud music; older resident comes out to complain, police arrive
Smart Road	Cars drive on road while weather conditions change from good to bad
Cliques	Kids on school playground form groups based on their “coolness” or “sports” interests
Classroom Bully	Bad kid picks on others in class; a teacher punishes him and gives him detention

Table 2: Sample simulations provided for exploration and comment.

CREATOR Refresher Tutorial

During the refresher tutorial, we again observed that the women had trouble keeping up with the pace set by the students. The boys and girls often jumped ahead and did extra experimentation on their own. As a result the "walkthrough" became a bit chaotic, with different users attempting different actions at different times. The women tried to follow the step-by-step guide we had prepared, but became confused when the questions being asked or answered did not relate to what they were trying to do. In several cases, a member of the research team sat down with an older woman to offer additional assistance during these exercises.

These differences in learning style emphasize the different needs of these two age groups. The students thrived in this interactive group setting, calling back and forth to one another with ideas and tips, and so on. In contrast, the older women sought a controlled, self-paced interaction with the new ideas and skills (Wissman, 2002).

We also noticed differences between the boys and the girls and older women: in one exercise that involved addition of a new object to an existing simulation, all of the boys added characters that made the project more game-like, but in doing so often lost the "community message" of the simulation. In one extreme case, B1 deleted all of the students in the Cliques simulation, replacing them with a flock of bomb-dropping birds; B3 and B4 added alien characters; B2 constructed a very detailed animation of a girl-eating cat. The boys clearly enjoyed themselves as they attempted and accomplished quite sophisticated programming, but they seemed to ignore the community-oriented goals of the simulations. In contrast, the women and girls made simple enhancements that did not diminish the community-related content (e.g., a cloud moving across the sky).

Cross-Age Collaboration

Although every attendee worked on a collaborative project during the workshop, two of the girls worked only with members of the research group (the two women they were to have worked with were unable to attend). In cases where a researcher formed part of a team, we made a concerted effort to let the "real participant" generate the ideas and act as the driving force behind the simulation projects. Thus the discussion of cross-age collaboration is based largely on the experiences of Team1-Team4 from the first workshop and Team5 from the second (Table 3).

Extensions to Existing Simulations

The first collaborative project involved the enhancement of an existing simulation. Three of the cross-generational groups (Team2, Team3, Team5)

cooperated in this, although they varied somewhat in the relative contributions made by the students and the women. Team2 began with a conversation initiated by B2, who queried W2 "What are your ideas?". When W2 responded, "I don't know what we are going to do", the boy quickly proposed to expand one of the schoolyard simulations to include basketball teams and a game (Table 4). W2 agreed, but seemed to then adopt a relatively passive role, "This is going to be amazing how you are going to do it."

Group	Participants
Team1	Workshop 1: Initially B1 and W1, but later disbanded
Team2	Workshop 1: B2, W2
Team3	Workshop 1: B3, B4, W3
Team4	Workshop 1 (formed after Team1 disbanded): W1, R1
Team5	Workshop 2: G1, W4
Team6	Workshop 2: G2, R1
Team7	Workshop 2: G3, R2

Table 3: Team Composition

Team3 and Team5 were similar to Team2 in that the groups assumed from the beginning that the students would do the programming, with help from the women. However, the women in these groups were more active in choosing what to do. The two boys in Team3 wanted to enhance the Smart Road project, because they felt it didn't "do" enough. Their initial proposal was to cause the cars to slide off the road and crash when the rain came down; W2 gently suggested instead that they "improve" the road rather than making it worse, so the group worked together to make the car and raindrop animations more realistic (Table 4).

Team1: In Cliques, birds drop bombs that cause other birds to explode on contact
Team2: Sports-oriented students in Cliques get basket-shooting behaviors
Team3: Smart Road improved to look more realistic in its animation of rain
(Team4: This team had not been formed at the time this activity took place)
Team5: In Noise Pollution, participants given a more elaborate interaction
Team6: Classroom Bully extended to pull out a straw and throw spit wads.
Team7: Kid hassled by Classroom Bully pushes back to defend himself

Table 4: Simulation Extensions

Team5 reflected a more balanced contribution of ideas from the student and the woman. Although G1 tended to take the lead in proposing ideas, W4 often helped to extend or refine the ideas. For instance, G1 suggested they that they could add more police cars to the Noise Pollution project, and W4 expanded this to consider an implication, "We probably need to get our people off the road before they get run over". This illustrates the general interaction pattern for Team5: G1 would propose an idea or modification, W4 would react and suggest refinements. Like Team2 and Team3, this team focused on making an existing simulation more realistic (Table 4)

One of the cross-generation groups (Team1) was unable to establish a collaborative working style. B1 was extremely interested and experienced with computer-based activities, particularly gaming. As in the other teams, he acted as the programmer; but unlike the other students, this boy was so absorbed by his own ideas that he never consulted or tried to interact with his partner. B1's game-oriented extensions did not appeal to W1 (birds dropping bombs), so there was little for her to contribute. After we made several failed attempts to "repair" this collaboration (e.g., asking B1 to consult W1, to consider more ideas), we disbanded Team1 and established a new collaboration between W1 and R1, so that W1 could work on creating a new simulation.

Two teams comprised a girl and a researcher. In these cases, the researchers made an effort to extract ideas from the students so that the projects "belonged" to them. The girls did the programming; the researchers served as coaches. Both of these girls chose to enhance the Classroom Bully simulation, making it more interesting or fun from their own points of view (Table 4).

One important consequence of the simulation extension activity was that each team established a general collaboration style: breakdown (Team1); student-driven interaction with occasional mentor-like input (Team3); relatively balanced interaction of proposal and refinement (Team5); and "student-teaching", wherein the student explained CREATOR programming (Team2).

Development of New Simulations

In earlier project work, we have observed that residents are most engaged by simulation problems that make a personal connection to their own lives and community-related interests (Rosson et al., 2002). As a result, we encouraged workshop participants to brainstorm about their own community interests that might be the topics of a CREATOR simulation. For the women, typical ideas related to their hobbies or their community activities, for example a sewing club, managing the library bookmobile, or participation in the annual downtown festival. Similarly, the students' ideas seemed to express their own sense of "community", for instance getting lost on the first day of school, town rules for using skateboards downtown, or reactions to substitute teachers.

Team1 (minus W1): Robber comes from hide-out and holds up convenience store; if policeman sees theft, robber is shot
Team2: Cars travel through a comprehensive grid, turning right, left, or going straight on.
Team3: Cars (and other odd creatures, a dragon, ants) travel past a storefront designed to model downtown Blacksburg
Team4: Optional activities offered in retirement community (a banjo concert, a card game); residents prefer the music
Team5: Cars arrive at a downtown intersection from multiple directions at once, and crash into each other
Team6: Stray cat eats food set out near a house and multiplies into two cats; two cats fall in love and produce more cats
Team7: Kids are walking around in the hall at school; when a pretty girl comes through the door, a cute boy falls in love with her

Table 5: New Simulation Projects

Given the rather diverse personal contexts and interests of the different age groups, we found it interesting that all three cross-generational groups chose to build new simulations involving some aspect of traffic management (see Table 5): Team2 worked on a traffic grid, Team3 on a model of downtown traffic congestion, and Team5 simulated an accident at a downtown intersection. We speculate that traveling around one's town in a vehicle is a salient and pervasive community behavior that all residents share, enabling contributions by all members of the team. Driving is also a very concrete problem domain, making it easy to visualize cars engaging in stereotypical "traffic scenarios" (e.g., busy streets, speeding cars, accidents). Driving is governed by familiar laws and conventions; this may make it an especially evocative context for surfacing and discussing community values. Finally, the public nature of traffic laws may cause the underlying values to seem uncontroversial, with the result that traffic issues are a "safe" topic for collaboration by dissimilar individuals.

The four other simulation topics were determined instead by participants' individual interests (recall that the researchers participated only as coaches in these groups): Team1 built a cops-and-robbers game where on some occasions the robber got away, but on others he was caught; Team4 explored the differential "attractiveness" of musical performances versus card game activities at a retirement center; Team6 simulated the effects of feeding stray cats around one's home; and Team7 built a project exploring high school romances.

Within the cross-generational groups, we observed the same styles of interaction during creation of new simulations that we had seen during the extension activity: Team2 was characterized by B2's programming efforts,

accompanied by explanations for W2's benefit; in Team3, most of the ideas and programming was done by B3 and B4, with occasional refinements by W2; in Team5 a relatively balanced interaction of suggestion and elaboration took place.

We also examined in more detail the content of the questions or suggestions offered by the women to their student partners. Our original expectation was that older residents would provide a sort of "community conscience", bringing up issues that emphasized concerns or details specific to the local community. We saw some evidence of this during simulation programming, although this input was at a fairly low level of abstraction. For example, during Team5's work on traffic accidents, W4 provided a real world setting:

W4: "Do you want the cars to have an accident?"
G1: "Yeah...where's there an intersection in Blacksburg where they could have an accident?"
W4: "Alright, Tom's Creek" [a busy intersection near the university]

Similarly, Team3 was working on an idea related to the traffic congestion the town experiences when Virginia Tech students arrive back in the fall. They first wanted to create an appropriate background for their road and cars. B3 and B4 were quickly able to open and begin using a paint program to draw storefronts:

B4: "We're just gonna write down 'building' on a little square."
B3: "Yes, like, there are signs that tell you what the shop is. We can call it a 'shop building'.
W3: "Are you going to call it 'building'? Oh, come on, you could call it something creative, like Kroger's"!
B3: "This is downtown though. We just choose a random spot to do it...the place by Rocket Music and Souvlaki's, where the old middle school is."
B4: "Souvlaki and Dairy Queen, where there's always concerts, the pizza place."

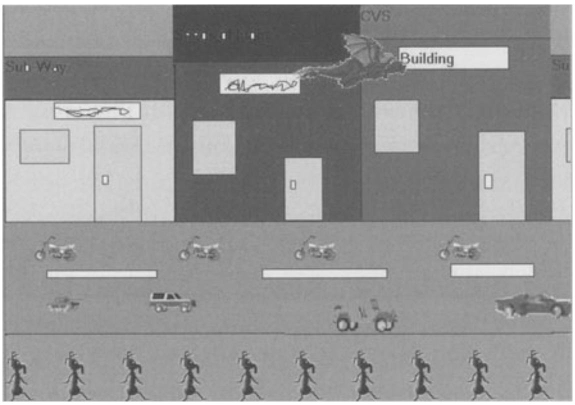

Figure 4: Downtown traffic congestion simulated by Team3.

Here, a modest "correction" by W3 prompted the boys to remember and share specific downtown experiences, and to position their simulation at a familiar downtown spot. This made the simulation project more concrete and tied to the team's shared understanding of "downtown" and helped in coming up with more details concerning the look and behavior of the simulated world. Nonetheless, as can be seen in Figure 4, this project ended up as an interesting mix between the "realism" that one might expect of an adult simulation developer (e.g., actual store names) and the "fantasy" that seems to be engaging to boys of this age (marching ants, a tank driving down the street, a flying dragon).

These conversation snippets reflect the community mentoring we expected from elders. Additional examples come from the comments about the sample simulations: where women's comments tended to relate to the community issue the simulation had been built to raise. For instance, W2 reacted to Noise Pollution: "I agree that courtesy demands speaking to the neighbors first before calling police. Also, where is a responsible adult?" In contrast, the students tended to focus on simulation usability or realism problems (e.g., "OK...I don't see what is happening here. This one is too short to understand."). We speculate that the women took the simulations (and our COMMUNITYSIMS project goals in general) more seriously, such that they made a more concerted effort to initiate community-oriented discussion.

Our expectation that the students would be eager and able to take on the task of CREATOR programming was also confirmed. An interesting side effect of students taking on this role was seen in the Team2 interaction, where the student became the "mentor". In this case, both B2 and W2 were sociable and articulate individuals, but B2 had a better understanding of how to use CREATOR. He adopted the habit of narrating what he was doing; W2 often asked questions to learn even more about how CREATOR works as the programming took place. This suggests a novel community collaboration wherein young people serve as mentors in raising the computer literacy of older residents.

Reactions to Workshop Activities

A second goal of the workshops was to explore participants' interest in community simulations. Our vision is one of informal education, which means that project involvement will be voluntary and thus very influenced by participants' intrinsic motivation. We gathered preliminary information about these issues by asking workshop participants to react to a) the example simulations; b) a set of hypothetical simulation features; c) working in cross-age teams; and d) the overall project goals.

Reactions to the Example Simulations

In the first year of the research project, we developed a number of example simulations to use in training and to convey the essential vision of "community-oriented simulations"; several of these were developed in a participatory fashion with other community members (Rosson et al., 2002). These example projects (recall Table 1) were posted on the web site and provided for exploration during the early phases of the workshop.

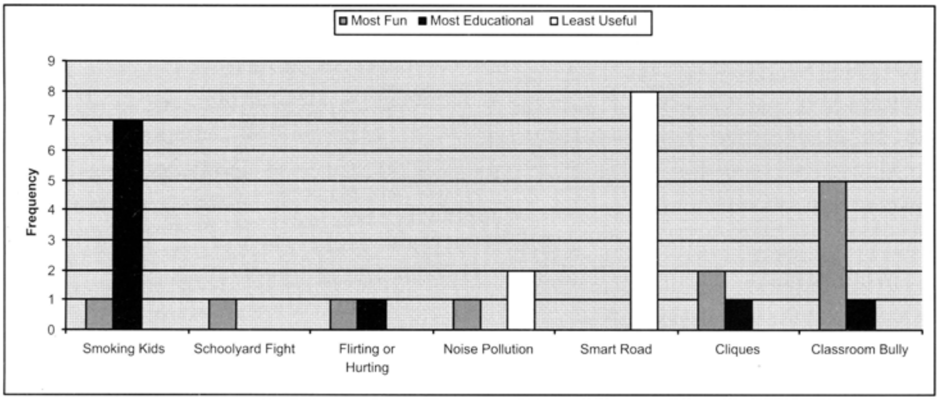

Figure 5: Simulations identified as most fun, most educational, and least useful.

During web site exploration, participants left a total of 26 comments about the example simulations. 22 comments were contributed by the students, and most of these had a negative tone, for example complaining that "nothing happens", or that a simulation was "boring". As mentioned earlier, only the women commented on the community issues the simulations were intended to raise. Although the reactions of the students were disappointing, they are consistent with our general impression that they viewed the simulation effort as more of a game than a community-related activity. We speculate that to engage these young people, we must make the topics more exciting, or investigate ways to engage the youth in elder-led discussions.

After trying out the simulations posted on the web site, participants were asked to choose the example simulation that they thought was most *fun* to use, most *educational*, and *least useful*. As suggested in Figure 5, there was considerable agreement about what was most educational (Smoking Kids, 7/11) and least useful (Smart Road, 8/11). There was less agreement about what was most fun, although 4/7 students chose Classroom Bully because "it was funny".

In general, participants said that they preferred simulations with a clear message, or that "did" something. It is difficult to visualize the impact of a smart road (it measures changes in a car's movements) or a noisy neighborhood party, whereas it is very obvious that a bully has hit someone, or that a kid has collapsed

after smoking for a while (of course the bully and smoking topics are also more personally relevant to middle school students). As we work with community members on simulations of their own design, we will encourage them to include very visible and obvious outcomes as part of their programs.

Reactions to Hypothetical Simulation Features

Also after exploring the example projects, participants completed 21 scales rating the extent to which a hypothetical feature could make a simulation more "fun". In this case, we wished to explore a wide range of characteristics, to see what sorts of simulation behavior might be appealing, and whether this would vary for the two age groups. We created the list of features by reviewing the simulations we had built or viewed, as well as by brainstorming characteristics we felt might be attractive. We tried to include features we thought would appeal to middle school students (e.g., cute, silly), but also to include more "serious" concepts we that might appeal to older adults (e.g., educational, matches the real world).[2]

In general, the students (particularly the boys) gave more positive ratings to all of the features, perhaps because they had more fun overall with the projects, or because they were more comfortable with computing technology. The women and the students also showed a fair amount of agreement on several of the features, for example agreeing that having more "action" and "artistic detail" would make a simulation more fun. They also seemed to agree that some features were less likely to increase the fun of using a simulation, for example both age groups gave relatively low ratings to the features "educational" and "moral lesson".

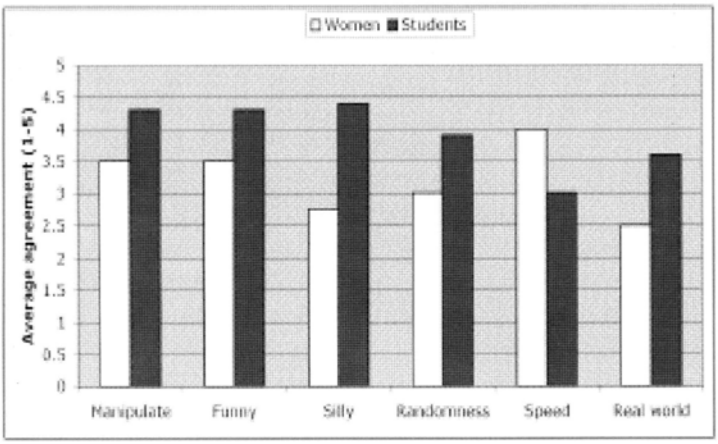

Figure 6: Average ratings of six hypothetical simulation features, for women (N=4) and students (N=7).

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[2] We have limited our report of these ratings to descriptive statistics due to the small sample size and the exploratory nature of the "funness" rating scales.

However, we also observed differential reactions to features. Figure 6 contrasts the ratings of the women and the students for the six scales with the largest cross-age differences. The largest difference is for "silliness", and the second largest for "real world". Some of these differential ratings can be explained by the students' desire for more game-like simulations; again, this was particularly apparent in the boys' ratings, who rated features like "randomness" and "manipulate" much higher than the women and girls. In fact, one unexpected finding was that the pattern of the girls' ratings was more similar to the womens' (r = 0.39) than to the boys' (r = 0.03), leading us to wonder whether gender will be as important (perhaps even more important) as residents' age in predicting reactions to the topic or style of a community simulation.

Reactions to Cross-Age Collaborations

At the end of the workshop, participants completed a survey questioning how easy it had been to work with their partners on simulation projects, and what might be done to facilitate collaborative projects in the future. The group was moderately positive about their overall collaboration experience (averaging 3.73 on a 5-point scale). However, several participants voiced concerns about the difference in ages:

W2: "I was overwhelmed and could not keep up with teenagers".

W3: "The young folks are so aggressive with the computer."

G1: "Just make sure that your partner is someone of around the same age so you will agree on more things."

These comments—in conjunction with the learning style differences reported earlier—lead us to conclude that real-time collaborative programming may not be the most effective way to establish cross-generation interaction. We need to search for alternative mechanisms for bringing these groups together, for example an asynchronous collaboration in which elders suggest topics or comment on students' projects. Another possibility is to make an explicit shift in the "direction" of the collaboration and help, for instance asking students to mentor elderly residents in the construction and use of visual simulations (recall Team2).

General Reactions

At the end of the workshop, participants provided comments about their experiences, and rated their interest in working with simulation activities in the future. Figure 7 contrasts the responses of women and students on four items: whether Creator simulations can help to build community; whether participants want to build or to extend simulations; and how well they understand Creator. Whereas the students were moderately positive in these final ratings, the women's ratings suggest some uncertainty about future activities. Notably, the average student rating of Creator knowledge was 4.0 whereas the women's average was

2.5. However, the women seem to have accepted our community education goals more than the students; the women's agreement that Creator simulations can help to build community was 3.25, compared to a rating of 2.71 for the students.

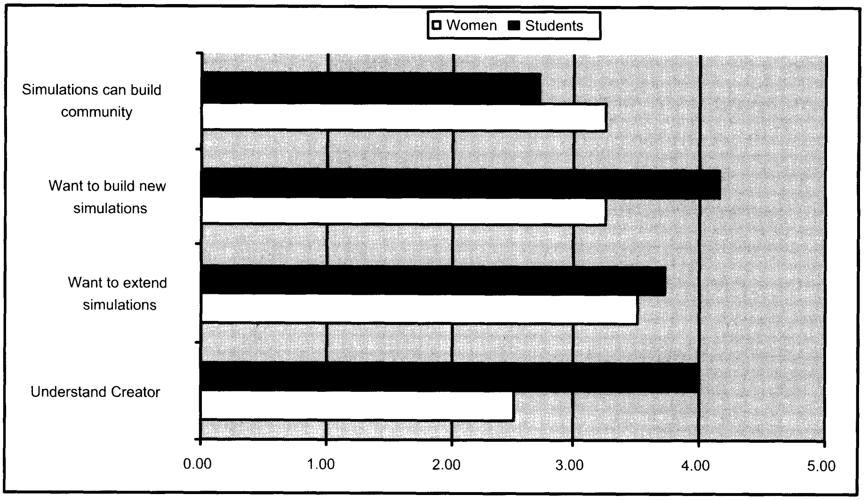

Figure 7: Average agreement (1-5) of women (N=4) and students (N=7).

Participants' comments reinforced the patterns seen in the rating data. All participants answered "yes" to a question asking if they wanted to continue to work with us in CommunitySims. But the nature of participants' future plans varied: three of the four boys tied their interest to game development (B1: "I'd like to make games out of existing sims"), whereas all four of the girls conveyed more general positive reactions (G3: "Yea, I though it was really fun when we got to make our own world and that kinda stuff"). Although the women also answered affirmatively, each was careful to qualify her future involvement (W4: "Yes, but I need to have more knowledge about creating a simulation project").

Summary and Discussion

We conducted two workshops to investigate the nature of cross-generation collaboration, and to explore features of community simulations that might make them more or less appealing to different age groups. Despite the small group size, we identified several interesting patterns in learning and collaboration style, and in reactions to the content of the community-oriented simulations.

The learning sessions were somewhat chaotic, with individuals jumping around, asking idiosyncratic questions, offering tips, and so on. The students thrived in this atmosphere, but the older women became confused and needed assistance to synchronize with the group process when they fell behind. In the future, we will rely on workshops to introduce and inspire student participants,

but provide more systematic, self-paced instruction for the older residents. We were also impressed by the "student-as-mentor" interaction style of one group, and plan further investigation of this novel form of cross-age collaboration.

The cross-generation interactions varied widely—from complete failure, to a very balanced give and take of ideas. One interesting observation was the choice of traffic as a problem topic for these groups. We now wonder if there are pervasive community experiences appropriate for cross-age discussion, situations in which any community member would have an obvious stake. Until now, we have focused on *controversial* issues as a means of attracting participation, but it may be that we will have more success in "bootstrapping" interaction among diverse community members if we identify and focus on *generic* issues. Topics associated with personal values (e.g., sexual harassment, the use of drugs) may be difficult to raise and discuss among an unfamiliar and diverse group of community residents.

With respect to simulation features, the users agreed that a good simulation has characters that "do" something. However, the students—particularly boys—clearly viewed the simulation activities as more of a "game" than the older women. For example, the boys spent considerable time adding game-like features to the existing simulations and were more likely to rate hypothetical features such as manipulation, silliness, sounds, and randomness good contributors to fun—these same features would cause the simulations to be more like computer games. At the end of the day, several boys expressed an interest in turning simulation projects into games. With respect to engaging young people, a challenge for us will be to identify topics that can at once address community issues but also have a silly or game-like character (e.g., the smoking kids who "die" and then recover and start smoking again).

As expected, the elderly women seemed to better accept our vision of community education, helping to ensure that projects contained community-specific content, contributing issue-oriented comments to the example simulations, and agreeing at the end of the day that simulation development activities might provoke community discussion. Student contributions tended to be more individualistic and game-oriented, emphasizing the importance of modeling by adult community members.

Our long-term goal is to form a learning community from residents with diverse backgrounds and motivations, providing complementary skills and contributions. The combination of our earlier learning studies and the workshops described here have helped us to articulate several tactics for building such a community:

- Develop additional training materials and examples that help users to build game-like simulations while still addressing "serious" topics.
- Recruit students via lively and open-ended workshop activities, but offer to elders a 1:1 or carefully structured environment.

- Explore the role of *mutual* mentoring, where students assist elders with simulations, and elders demonstrate simulation of community topics.
- Introduce young people and elders in a real world setting, but mediate subsequent project collaboration with web-based asynchronous tools.

Community networks leverage and develop local resources through online collective endeavor. One of the most precious resources any community has is its elders. This has always been true, but today it may be even truer. Our elders have been called the civic generation because of their lifelong commitment to community issues and institutions (Putnam, 2000). CommunitySims is only a first step, but its goal is to leverage and develop this precious resource through mutually-engaging, cross-generation collaborative learning.

Acknowledgments

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The African Dream: A Pan-African E-community Project

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Abstract. The African Dream Project[1] seeks to develop community-based tourism by creating a technology-based solution to global marketing. They have chosen to do this by developing tourism routes across Africa, uniting them under the umbrella concept of Afrikatourism. This paper reports on a study done in the Eastern and Western Cape provinces of South Africa to determine the communication and coordination practices of tourism routes[2] that form part of a Pan-African e-community under the auspices of the African Dream Project. The study seeks to devise a model for maintaining cohesion of the routes through effective and efficient ICT[3] and non-ICT practices. It is part of a 2-year study funded by the IDRC to determine the potential impact of ICT on the development of microenterprise in the tourism industry, entitled the SOMDITTI Phase 2 project.

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1 In December 2002, the African Dream Project comprised 32 routes covering 11623km in five countries, involving 80 towns and 791 establishments that support 5798 direct full-time jobs in season and 2344 part-time. Team Africa, the project driver, had 2331 individual, corporate, institutional, professional and partner members. The web sites registered an average of 679 page impressions per day (1888 hits) for the month of September (Source: Footprints, Open Africa newsletter, December 2001).

2 The terms 'route' and 'routes' refer to collections of thematically linked destinations and tourism services in an area. They are not physically linked, as in a trail.

3 Information and Communications Technology

M. Huysman et al. (eds.), Communities and Technologies, 227-240.

Background

The digital divide is not a single thing, but a complicated patchwork of varying levels of ICT access, basic ICT usage, and ICT applications among countries and peoples.

Quote from'Spanning the Digital Divide- understanding and tackling the issue'
A report by bridges.org

In his report on Tourism, Development and the Internet for the UN ICT Task Force (2002), consultant Roger Harris states that tourism is the world`s largest industry and the biggest single e-commerce industry, with over 38% of the US$64 billion transacted on the Internet in 1999 being related to travel. He continues with 'tourism is also an information-intensive industry and the Internet can satisfy this need for quality information far better than any other technology'.

However as figures from the Digital Opportunity Task (DOT) Force in table 1 shows there is a growing disparity between the number of users of the Internet in developed and developing countries.

		1995	1996	1997	1998	1999	2000
Internet users (in millions)	Developing countries	3	7	13	25	51	83
	Developed countries	30	47	77	124	180	232
% penetration	Developing countries	0.1	0.1	0.3	0.5	1.0	1.6
	Developed countries	4	6	9	15	21	28

Table 1: Growth and penetration of Internet users (DOT Force)

According to the report on 'Spanning the Digital Divide' by Bridges.org, when computers are introduced in a country, they exacerbate inequality, usually benefiting privileged communities first.

It is against this backdrop that the African Dream Project was initiated, to give African microenterprises in the tourism industry access to the Internet on a collective web site. The initiative creates local content via a community tourism development process, and makes it accessible to global markets without taxing the resources of the information providers. This paper explains more of the working of this E-Community.

Southern African development

Inequality

Reducing inequality and poverty, and tackling unemployment and underemployment, are some of the key challenges faced by government. The immediate cause of poverty is huge inequalities in access to productive assets land, basic infrastructure and capital as well as to education and skills.

Quote from the web site of the Department of Trade and Industry of the South African Government (www.dti.gov.za *)*

Since the first democratic elections in South Africa in 1994, the new government has been trying to redress the negative economic and isolationist effects of the Apartheid era.

Small business and tourism are high and visible on the development agenda. However there are still significant developmental problems to be addressed in the country.

Figures below indicate the socio-economic situations in South Africa and Lesotho. Both countries form part of the study explored in this paper.

	South Africa	**Lesotho**
Population (millions)	43,1	2,1
Area (1000 km²)	1,200	30
% of population below the human poverty index	20,2	23,3
Adult illiteracy rate	15,4	17,6
% with lower than Grade 5 education	35	20
GDP per capita ($)	8488	1626
Gini co-efficient	0,59	0,57

Table 2: Socio-economic indicators for South Africa and Lesotho

Tourism Development

Focus and co-ordination: communities involved in route developments are focused around a vision of common purpose. This has the further benefit of achieving a level of coordination and cooperation that hitherto has been impossible among the multi-faceted participants in tourism.

Quote from African Dream Project web site (www.openafrica.org)

There is a plethora of tourism development agencies in South Africa. At national government level there is the Department of Environmental Affairs and Tourism. Each of South Africa's 9 provinces has a tourism portfolio within one of its government departments. There are parastatal tourism boards at the national and provincial levels, 10 in all. There are also active tourism development authorities

at the regional, metropolitan and local government levels. For example, in the Cape Town metropole, routes could deal with up to 9 different tourism authorities.

All these organisations are being kept busy and are able to justify their existence in light of the fact that tourism is growing in South Africa and that it is one of the few options open to small business development in disadvantaged areas because of the low barriers to entry. However service standards and information available vary between regions.

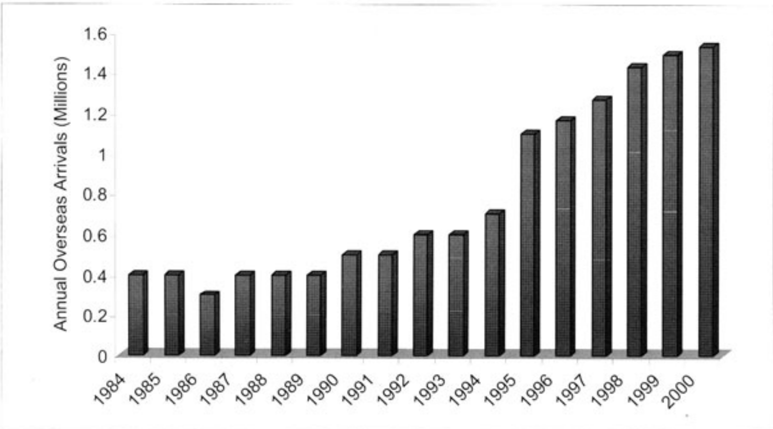

Figure 1: Overseas arrivals – South Africa (Wesgro)

South Africa's 2002 total tourism figure is 6 429 583 of which 4 455 971[4] were visitors from Africa. The three biggest markets by continent are Europe (1 252 710), North America (216 275) and Asia (177 415).

It is these 2 issues of inequality and tourism development that the African Dream Project tries to address, within the context of the digital divide by giving all route participants free access to web based marketing.

The African Dream Project

During the study, the research team worked closely with Open Africa, the functionary tasked with realising the African Dream Project. The following information was gathered from this interaction and from the project web site www.africandream.org.

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4 According to Wesgro, the Trade and Investment Promotion Agency for the Western Cape, 'The majority of African visitors are cross-border travellers including job-seekers, shoppers and traders from neighbouring countries. African cross border arrivals account for some 70% of all foreign visitors'.

Open Africa is registered as a non-profit organisation. It has a flat organisational structure and operates out of a small office in Cape Town. Noel de Villiers, the founder, provides day-to-day leadership and management and is the organisation's premier spokesperson.

Operational staff include a project leader / Webmaster, a person responsible for the GIS[5], content design and maintenance and two field officers. Mr de Villiers and the field officers are also involved in fundraising. Additional resources are contracted in as needed.

The motivation of the African Dream Project is to 'turn Africa's natural and cultural heritage into one of the most valuable products on earth, through Afrikatourism - a unique model of tourism specific to Africa'. The vision is to 'link Africa's splendours through a network of Afrikatourism routes from the Cape to Cairo'.- www.africandream.org. The objectives of the project are:

- Tourism development
- Job creation
- Promotion of the routes
- Building community morale and pride
- Benefits to Internet Users
- Conservation

A 90-day route development methodology, backed by the use of information systems such as GIS and database, has resulted in the development of 32 routes in 3 years. Afrikatourism is the unifying brand name and the African footprint is the community's logo. All stakeholders, ranging from sponsors to route participants, form part of Team Africa.

Route participants are representative of all forms of tourism businesses, ranging from micro to big. None of the participants pay for their participation in the project, consequently all are equal. The work is sponsored by a range of corporates, government and tourism authorities and private trusts. However, as stated in the route development workshops, the cost of belonging is high – a commitment to adding value to the route.

The system is run on a Pentium using Windows NT. An Access database is used for search engine and Java is used to query the Arcview GIS. Web server software, an HTML editor and photo editor are also used. Hosting is off-site. There are 2 web sites, www.africandream.org and www.openafrica.org. A GPS is used for positioning and a digital camera for taking photographs. Laptops and data projectors are used for presentations in the field. Figure 2 shows the web site hits for April to August 2002.

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5 Geographical Information Systems

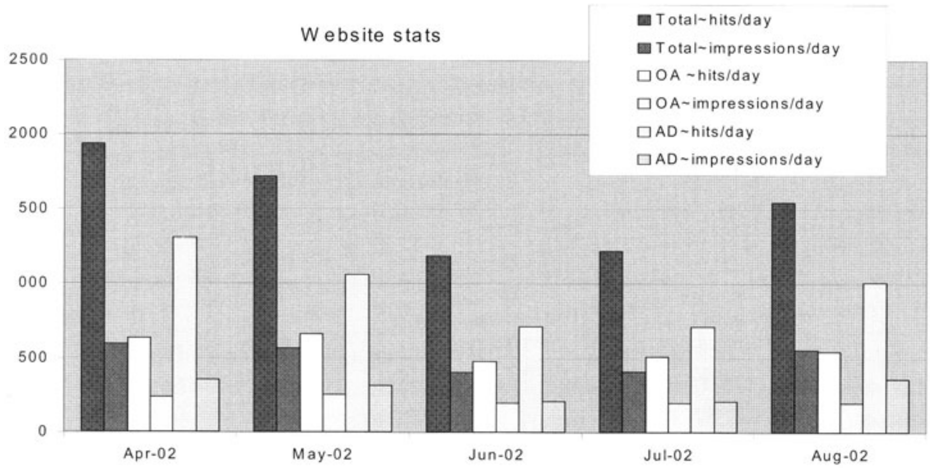

Figure 2: Web site statistics (Open Africa)

Route Development Process – the establishment of the E-Community

Open Africa does not canvass for routes but rather invites communities or routes to approach them to become part of the African Dream Project. No group is turned away as the assumption is that there is tourism potential in every area or situation. There are routes in such diverse situations as disadvantaged communities in large cities and mountain villages in remote rural areas.

Funding from an outside source is then sought, either by Open Africa or by the group. Currently the cost of developing a route in South Africa is approximately \$10 000. Costs rise the further the route is from the organisation's base in Cape Town.

Three workshops are held at 6-week intervals. All participants for that route are invited to all of the workshops, which are held in the area of the proposed route. Participants are encouraged to identify others to join so numbers usually grow with each workshop. The entire process from the time the Open Africa field officer meets with the group for the first time, to the launch of the web site, takes 90 days.

During the first workshop, a 60-minute presentation is shown to the audience, which explains the African Dream Project and associated concepts. A route forum is elected by the group to drive the process in between workshops and one person is identified to liaise with Open Africa. The attractions on the tourism route are identified.

Between the first and second workshops, participants fill in forms with all the data required for the web site. Information about the area is also gathered, such as seasonal activities, condition of the roads, useful tips; etc. A road map of the route is requested which will be digitised and uploaded onto the site for viewers to print.

During the field officer's second visit to the area, GPS positioning of all destinations and attractions on the route is recorded. If participants are not able to provide photographs, these are taken by the field officer. At the workshop, all outstanding information is collected and decisions are made about the name and contact person.

The launch takes place at the third workshop. It is usually a gala community event with guest speakers ranging from community leaders to politicians to sponsors. During the workshop, the route participants are advised on how to promote their route and their businesses further.

At any time after the launch, the data for participants can be changed and new participants added. If a route is to be extended significantly, a new 90-day process is initiated.

After a route is established, Open Africa's associates on Team Africa promote the routes. Promotions include articles in Africa Magazine, a full-page map and article in a quarterly publication on tourism by Open Africa's major sponsor, Engen[6].

The Study

Liaison persons of five routes were visited for face-to-face interviews by 3 members of the study group. The interviews were structured, with the interviewers filling in questionnaires. Meetings were lengthy and informal and much time was spent in discussion. Anecdotal evidence was collected in the form of comments.

The routes are spread out over the Eastern and Western Cape provinces of South Africa and across the border into Lesotho, a land-locked country. The routes are all situated in rural areas, ranging from an impoverished township near a small town to the mountainous areas around Lesotho. All but one are spread over vast distances. Details of the routes' backgrounds are tabled in Table 3 below.

6 Formerly Mobil

Route name:	*Blue Crane Caledon*	*Southernmost Blue Crane*	*Kwa Mandlenkosi*	*Maloti*	Thunga-Thunga
Date established	1 March 2001	3 July 2002	27 October 2001	Originally in 1998, launched on Open Africa site 10 Dec 2002	12 May 1999
Catalyst for establishment	Conservation of the Blue Crane	Caledon Blue Crane extension	Community project	Poverty relief initiative in Lesotho.	Create benefits for local communities
Route setting:	Western Cape Rural – mostly farmers	Western Cape Rural – mostly farmers	Western Cape Karoo desert Rural – township	Cross border – Eastern Cape; eastern Free State; Lesotho - Rural	Eastern Cape Rural
Theme:	Conservation and awareness of Blue Cranes	Conservation and awareness of the Blue Cranes	Townships and township life in the platteland	Maloti Mountains of Lesotho	To follow the footsteps of Mandela
No. of participants	16	15	15	89	68

Table 3: Route backgrounds

The study seeks to determine the issues pertaining to common vision; cohesion; coordination; communications; collaboration; the measurement of impact; the use of ICTs and the challenges faced by the route.

Further data is to be collected. Using the current questionnaire, telephonic interviews will be conducted with African Dream Project routes far from Cape Town. Face to face interviews will be conducted with Open Africa routes close to Cape Town and with route coordinators of older and bigger routes that are not part of the African Dream Project, e.g. Wine Routes in the Western Cape and the 1000 Hills Experience and Midlands Meander in KwaZulu Natal. Model and recommendations will be drawn up and these will possibly be included in a revised plan for the African Dream Project.

Common vision

As stated the vision for the African Dream Project is to *'link Africa's splendours through a network of Afrikatourism routes from the Cape to Cairo'*. It is a Pan-African vision for tourism development, which is presented at the first workshop of every route.

Two respondents stated conservation as the major focus of the route, others stated that poverty relief, job creation and community development were the major driving forces. Only one route stated tourism as the primary focus. The route fora adhere to their own vision and not necessarily to the Pan-African vision of the African Dream Project.

Tourism development, which is one of the African Dream Project objectives is in line with the objectives of local government and tourism development authorities. Those routes championed by tourism authorities stated that the routes gave them vehicles to introduce emerging businesses and tourism products in their areas.

Route participants are largely interested only in the marketing of their own businesses. They recognise the value of the collective marketing opportunities that the African Dream Project affords but are not exclusively members of that route. There was no evidence of buying into the African Dream or the routes' visions.

Cohesion

The study found that the cohesion of the routes was largely due to the efforts of one person or champion in each route. None of the routes employ any permanent staff members. However of the 5 routes studied, 3 of the champions were employed by tourism authorities in the area and one was sponsored by a corporate to create awareness of conservation of Blue Cranes in the area. The champion of the remaining route had been employed by a sponsor, specifically for the route but is now is self-employed as a participant on the route.

Only one route has a legal persona. The Thunga Thunga route has been registered as a private company with a limit of 50 participants as shareholders. In addition, all 68 members are members of a voluntary association. Two routes charge membership fees.

Communication

All staff at Open Africa have e-mail addresses and cellphones. One staff member is permanently stationed at the office. When the manager and field officers travel they keep in touch with each other and the office via cell phone as e-mail access is not always available in remote areas. At other times the team keeps in touch with each other by e-mail and project meetings.

All route forum liaison persons have e-mail addresses, cell phones, telephones and faxes. Communication between Open Africa and the route for a and Team Africa is by printed and electronic newsletter, telephone and e-mail.

All participants have telephones. Most have cell phones although the cell phone network does not extend into some of the areas covered by the routes.

In all but one route, participants and forum members live far from each other. The fora meet more regularly than the participants *(ad hoc; ad hoc; monthly; bimonthly; annually)*. Teleconferencing was used by one of the route fora and proved to be successful.

Open Africa is planning a conference to which two representatives from each of the 32 routes plus other stakeholders will be invited. Agenda items will include successes; synergies; stumbling blocks and sustainability.

Open Africa uses the partnerships within Team Africa that have promotions and public relations expertise to promote the routes to the tourism market. Promotional material, such as stickers with the web site address printed on them, have also been developed.

Most of the promotional material developed by the routes is printed, in the form of collective brochures. Other external communications include stickers; postcards; newspaper editorials; slots on television programs; trade shows and talks, e.g. targeting birding groups. There was not much use made of ICT to promote the routes.

Collaboration and support

Two of Open Africa's major sponsors, Engen (oil company) and Hertz (car hire), collaborated to develop a guide book of all the African Dream Project routes. This enabled Hertz to win a major account with a German travel agency.

Despite the fact that four of the routes have not been constituted as a legal entity, all are attracting significant support from sponsors, who were not involved in the initial set up of the route. Direct support includes brochures; bookings; sponsorship to trade shows; funding awareness workshops and skills development; infrastructural development; and in one case a route extension. Indirect support includes small business training in the area; the establishment of a tourism hotline; employment of a conservation worker. There is no evidence of collaboration between routes

All respondents noted that participants on the routes have collaborated with respect to festivals; craft markets; joint marketing and tour packaging.

Measurement of impact

The system developed by Open Africa has the capability to create and update statistics. These are gathered during the initial 90 day process. However the integrity of the data is dependant on timeous feedback from the routes to keep it

updated. Of the five routes studied, four were out of date because information was not forwarded to Open Africa. Anecdotal evidence suggests that the routes are growing in terms of numbers of participants, skills development; infrastructure; emerging businesses; and outside support.

Tourism bureaus record statistics on source markets, seasonality and growth. However this is not route specific. Feedback from the participants is oral and informal and would be available on request in some cases. Three routes kept statistics on how clients heard about the routes. They all stated that 80% or more of their clients heard about the routes through word of mouth.

Participants do not keep statistics of their business other than those required for financial accounting. No formal records, other than guest books, were kept on the origin of visitors. Participants interviewed noted that knowing how their customers heard about them and where they came from would help them to decide how to spend their marketing budgets.

Use of ICT

The African Dream Project is based on and committed to the use of the ICT and the Internet. However the hardware and systems need to be upgraded. This is dependant on funding.

All of the forum representatives interviewed had e-mail access, cell phones, faxes and telephones and used them regularly. There are problems with cell phone access in three of the areas studied and Maloti stated that there were problems getting technical ICT support.

All participants have telephones and most have cell phones. E-mail usage is higher on some routes than others. The reasons for this range from financial in the case of the Kwa Mandlekhosi route to lack of awareness in the Southernmost Blue Crane. Forum liaison persons complain of a reluctance by participants to learn and use ICTs.

What % of the participants have	*Blue Crane Caledon*	*Southernmost Blue Crane*	*Kwa Mandlenkosi*	*Maloti*	Thunga-Thunga
Telephones?	100%	100%	100%	100%	100%
E-mail access?	75%	40%	13%	62.9%	58%
Internet access?	68%	40%	6%	58.4%	52%
Their own web sites?	18%	0%	0%	24.7%	25%
Booking facility?	18%	6%	0%	12.35%	14%

Table 4: Participants' use of ICT

Challenges faced by the routes

All respondents stated that their routes were seasonal. Summer is the busiest season for all, then autumn (Easter) and winter. Snow is an attraction and a constraint on the Maloti route. Roads in some areas of the Thunga Thunga Route pose difficulty for travelers and make it more difficult for participants to meet. Some of the border posts between Lesotho and South Africa are not tourist friendly. The long distances of the routes made it difficult for four of the five routes to convene meetings of both the forum and the participants.

None of the routes employs a full-time worker. They are reliant on volunteers or staff of the local tourism authorities to drive the development of the route. Outside of the local tourism authorities, there is a lack of expertise in tourism and business management. Only one route has a visible central venue or presence, w a display area at the local tourism office.

The respondents stated that participants in rural areas prefer to communicate face to face. In some areas, participants speak different languages making communication a problem. ICT has not been utilised to make communication more efficient and effective.

Open Africa has attempted to put systems in place that result in data being kept updated. However there isn't an appreciation amongst the routes of the value of this information. Statistics on overall tourism activity in the areas is collated by local tourism authorities but the impact of the routes cannot be isolated and assessed accurately from these figures.

It is not evident that the participants would know what information would be useful. By and large participants keep information, which is pertinent to finances and taxes only.

There is less of a sense of urgency in rural areas, which means the time savings are of no real value. In the rural areas, people prefer to meet face to face so electronic communication does not have a strong appeal.

There is a lack of awareness of the benefits of ICT amongst participants. The perceived cost of investment in ICT is high and the participants are too dispersed to be able to share facilities. As tourism activity is the major activity in many of the small businesses, there are no other business reasons to purchase a personal computer, which then becomes an expensive device to purchase purely for communications.

Observations

The African Dream Project's concept of routes is modeled on the Wine Routes in the Western Cape, which are almost 30 years old. It is remarkable how much has been achieved by the routes studied in a short space of time, despite the lack of

permanent coordination structures. Much of this can be attributed to the energy of the Champions.

There appear to be different visions within the African Dream Project, which the various stakeholders need to be aware of. Expectations need to be managed accordingly.

There is scope to strengthen relationships at all levels, especially peer-to-peer networking, e.g. forum to forum. The benefits of this need to be articulated and the mechanisms put in place to make it practical.

Information flow needs to be improved at all levels. An analysis of useful information should be done and all stakeholders need to be made aware of the value of the information.

Participants need to be made aware of the benefits of using ICT in a global market and how they can access it at an affordable cost.

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The Role of Social Capital in Regional Technological Innovation: Seeing both the wood and the trees

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Abstract. This paper both attempts to identify the key conceptual and methodological principles that can be extracted from the very complex literatures on social capital and innovation, and to draw out the interactions between these concepts. The paper argues that the social capital literature has been hijacked at one end by those solely taken by precise definitions and measurement, and at the other end by those that proclaim social capital to be the blanket solution, and the missing link. If we allow ourselves to get caught up in the too miniature details then we risk losing important insights from a fascinating concept. At the other end, broad-sweeping claims about social capital risk devastating policy prescriptions. The paper attempts to show that yes social capital does exist, and yes it is important for regional technological innovation. However, social capital can also be a hindrance for regional technological innovation, and cannot replace other important regional development resources.

Introduction

This paper necessarily addresses existing deficiencies in the literature concerned with the role played by social capital in the process of technological innovation and economic growth. We have two very broad bodies of literature on social capital in the technological innovation context which have become very complex and consumed with definitional issues. It is therefore desirable to identify the key

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conceptual and methodological principles that can be extracted from the literatures, and to try to understand the interactions between these concepts (that is, social capital and innovation). The research focuses on the specific processes that impact on social capital in the context of regional technological innovation. The paper argues that the social capital literature has been consumed at one end by those concerned solely with precise definitions and measurement, and at the other end by those that proclaim social capital to be the solution to all the world's ills. Social capital does exist, and yes it is important for regional technological innovation, however, social capital can also be a hindrance for regional technological innovation, and cannot replace other important regional development resources. Essentially, the concept needs to be brought back into perspective, otherwise we risk losing important advances from a fascinating concept.

The remainder of this paper is divided into three main sections. The first section discusses the importance of technological innovation for economic prosperity in the new knowledge based economy (KBE), and identifies key themes of the stages and elements of the technological innovation process. The second section identifies key conceptual and methodological principles that can be extracted from the social capital literature, and draws out interactions between the social capital and innovation concepts. Lastly, the third section analyses the role of social capital in regional technological innovation and development, and makes suggestions for further research.

The technological innovation process

The literature on sustainable competitive advantage and the growth of firms, regions, and nations widely recognises the generation and use of knowledge as the most important element of that process. This recognition furthermore, has been reinforced by the development of the 'new knowledge-based' or 'learning' economy[1] in which a capacity for learning is considered a key attribute of success (Wolfe 2002:5, Maskell 1999). Innovation, broadly understood as the adoption, adaptation, and diffusion of novelty through firms and markets, is therefore seen as the essential source of economic dynamism, though this observation is not new, with writers as diverse as Smith, List, Marshall, Schumpeter, Marx, and Porter all viewing innovation as the primary foundation of competitiveness in capitalist systems (Lundvall et al 2001:5, Freeman & Soete 2000:2). In recognising that innovation is the primary source of competitive advantage, both Schumpeter and Marx realised that innovation could wield destructive as well as creative (hence Schumpeter's famous '*creative destruction*' metaphor) social and

[1] For a pertinent discussion on whether or not a 'new economy' actually exists, see Gordon (2000) and OECD (2000).

economic effects on existing inventions[2]. Schumpeter stressed the importance of 'quality' over 'ordinary' competition, arguing that it 'strikes not at the margins of the profits and the outputs of the existing firms but at their foundations and their very lives' (Schumpeter 1942). Thus innovation, because of its revolutionary capabilities, is paramount for growth, employment (in particular the growth of high-skilled and high-quality employment), productivity, environmental sustainability, and overall welfare in both regions and nations, and its generation should be of fundamental importance to governments and thus public policy (OECD 2001:7).

It is said that Schumpeter was the first to distinguish between invention and innovation (Cantwell 2001: 3), and it must again be emphasised that an innovation does not necessarily need to be 'new to the universe' (Nelson & Rosenberg 1993) but simply new to the firm, region, or nation. In the economic sense of the word, something is only considered to be an innovation when a commercial transaction of the new (or enhanced) product, process, system, or device is in motion (Freeman & Soete 2000:6). Schumpeter's understanding of innovation as a 'new combination' is fascinating because it highlights the fundamentally paradoxical nature of innovation: that is, finding a balance between continuity and change (Lundvall et al 2001:11), exploitation and exploration (Nooteboom 2000a:1) and evolutionary and revolutionary change (Tushman & O'Reilly 1996:8). Furthermore, innovation is often simply viewed as encompassing product designs and manufacturing processes, but innovation is broader than this, and includes institutional, organisational, and managerial technique changes (Morgan 1997: 492).

For a long time, the dominant approach to innovation has followed the orthodox 'science model' or 'input-output perspective', that is, the science push, market pull, research and development model (Langrish et al 1972: 72-3). The axioms underpinning this model, however, are far removed from the real world, and this approach is ill-equipped to deal with the innovation process. At the base of the orthodox model lie the behavioural assumptions about how actors in the economic system operate. It is assumed that consumers optimise utility (maximise benefits relative to costs) and producers maximise profits[3]. Preferences are taken as ordered, transitive, comparable, consistent, and purely internal (Sen 1977:

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2 Morgan (1997) refers to a passage in *Das Kapital* in which Marx uses the case of cotton to illustrate the power of innovation. Marx likens the process to a battle between the traditional hand weaving technology and the new power weaving technology, in which 'the bones of cotton-weavers ended up 'bleaching the plains of India'' (Marx 1954 [1867]).

3 Hume's explanation (1740 book 3, part 2, section 5, in Putnam 1993:163) of human nature is classic:

> Your corn is ripe today; mine will be so tomorrow. 'Tis profitable for us both that I should labour with you today, and that you should aid me tomorrow. I have no kindness for you, and know you have as little for me. I will not therefore, take any pains upon your account; and should I labour with you upon my own account, in expectation of a return, I know I should be disappointed, and that I should in vain depend upon your gratitude. Here then I leave you to labour alone; You treat me in the same manner. The seasons change; and both of us lose our harvests for want of mutual confidence and security.

322). Following a narrow reading of Smith[4], the utilitarians and later the rational choice theorists and neoclassical orthodoxy have particularly emphasised the extreme self-interest and profit maximisation motivation of economic agents (Coleman 1998: S95, Woolcock 1998:160). Another assumption of the orthodox account of innovation is that the economy is in a state of equilibrium and that innovation temporarily creates disequilibrium, and then moves back to equilibrium (Lundvall 1992: 8). A third assumption of the model is that innovation follows a linear trajectory, that basic research moves to applied research and then to commercial application, translating into better performing firms, regions, and nations.

The growing literature on the innovation process, however, rejects these assumptions, and Andersen et al (1981: 55) believe that the orthodox economic perspective on innovation 'has led to a misjudgement of some of the important mechanisms to the national and regional development process'. History has shown us that innovation does not follow the orthodox model, as regions and countries that have dedicated considerable resources to research and development, have not achieved economic success. Freeman and Soete (2000) illuminate the non-linear nature of the innovation process with a comparison of Japan and the former USSR. Both Japan and the USSR planned for the long-term (the Ministry of Trade and Industry in Japan, and the five year plans in the USSR), both directed considerable resources to basic research, and both had excellent technical education systems. The linear model of innovation oversimplifies the process, ***as systemic factors play a major role***. The major difference between the two cases of Japan and the USSR was that Japan had strong links between all stages of the innovation process, whereas the USSR had very weak institutional links. The reality is that a wide range of qualitative factors may act as impediments to a firm's, region's, or nation's 'absorptive capacity' (Cohen & Levinthal 1990).

There is now a voluminous literature (the National Systems of Innovation (NSI) approach, institutional and new institutional economic approaches, as well as the evolutionary economic approach) that firstly acknowledges that economic actors are motivated by a variety of institutions (understood as norms, habits, and rules of society), and that these are influential in shaping how actors interact, learn, and utilise knowledge (Johnson 1988, 1992, Sen 1977, Earl 1983, 1988, Etzioni 1988). Where the economic environment is characterised by uncertainty and continuous change, both the informal and formal 'institutional setting' will have a major impact on both the way that economic actors choose to behave, as well as the way in which the entire system will perform (Lundvall et al 2001: 17).

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[4] Many writers of these traditions overlook sections of *The Wealth of Nations* and his earlier writings such as *The Theory of Moral Sentiments* in their interpretations of Smith (Klamer 1989:141). Sen says that in reality Smith took a more extensive view of human nature and did not see the pursuit of self-interest as being uniquely rational. While Smith did see self-interest a major motivation, he did not exclude other factors such as humanity, justice, generosity, and public spirit. Smith saw the situation more as being the prudential pursuit of self-interest.

For example, the difference between the short-term outlook nature of corporate governance in the Anglo-Saxon system as opposed to the long-term nature of investment decisions seen in Japan, is illustrative in emphasising the key impact of institutional differences. Furthermore, many focal actors of the innovation process such as universities and publicly funded research think-tanks are established with a range of motivations other than profit maximisation (Edquist 1997: 6). Other formal institutions such as intellectual property rights, corporations law, and the industrial relations system are also fundamentally important to the innovation process (Dosi 1988: 1121, Lundvall et al 2001: 19).

The literature on the characteristics of the innovation process emphasises a number of notions. Innovation is firstly said to occur in a 'learning by doing and by searching environment' (Lundvall et al 2001: 13) (this informal element is said to be embodied in people and organizations, and its origins are hard to pinpoint (Dosi 1988:1125)). Innovation is furthermore conceptualised as a problem-solving activity involving both discovery and creation (Dosi & Egidi 1987), and emphasis is placed both on path dependency on the knowledge base (Neslon & Winter 1982) as well as on tacit[5] knowledge. This is because innovation requires previous formal and informal experience to be drawn upon. Formal knowledge is often in reality seen as complementary to tacit knowledge in the innovation process, for example the results of a Yale questionnaire in the 1980s showed that university research was considered to be important for innovation in only 30 out of 130 sectors surveyed (Nelson 1986). Moreover, in the 'new knowledge-based economy', where the flow of public information is rapid and widespread, the importance of 'know-how' and tacit knowledge is arguably even more important to create a competitive advantage. Freeman and Soete (2000:297-8) discuss how an important part of Prussia 'catching up' to Britain in the 1800s was not reverse engineering, but the transfer of tacit knowledge through the poaching of British craftsmen to teach Prussian craftsmen the know-how.

Further emphasising the path dependency notion, firms, regions, and nations are said to follow 'technological trajectories' in that activities are 'strongly selective, finalized in quite precise directions, and cumulative' (Dosi 1988:1128) (for example, a region or firm that is successful in producing chemical products, will rarely move to a mechanical technological trajectory – that is, there is the possibility of lock-in). In contrast to the orthodox assumption of firms, regions, and nations having perfect, easily producible, and reusable information, 'bounded rationality' of actors in the innovation system is emphasised, in that agents cannot comprehend all possible options, but instead 'satisfice' (Simon 1959, 1976). Localised learning is therefore emphasised (Lundvall et al 2001: 13), with the

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[5] Tacit here is conceptualised in the sense that Polanyi (1967) intended, that is:

> those elements of knowledge, insight, and so on that individuals have that are ill-defined, uncodified, unpublished, which they themselves cannot fully express and which differ from person to person, but which may to some significant degree be shared by collaborators and colleagues who have a common experience (Dosi 1988: 1126).

learning element highlighting the continual incremental nature of innovation instead of it simply being a single disruptive event that temporarily disturbs the state of equilibrium. As opposed to the purely internal orthodox conception, interaction with the external environment is stressed in the building of the knowledge base, and so, different contexts offer dissimilar prospects for processes of interactive learning (Dosi 1988: 1131-3). It is also argued that success in innovation requires long-term relationships (further emphasising the continual and gradual nature of innovation), many of which are necessarily of a non-price nature[6] (Lundvall et al 2001: 16). Lastly, Nooteboom (2000a:7) says that innovation, like crime, requires the motive (the build up of unsatisfactory performance), the opportunity (of demand and or the technology), and the means (insights into what novel elements to obtain from what source and how to incorporate them). So overall, the general features of innovation are considered to be 'tacitness, specificity, uncertainty, variety of knowledge bases, search procedures, and opportunities, cumulativeness, and irreversibility' (Dosi 1988:1164, Lundvall et al 2001, Nooteboom 2000a & c).

The concept of social capital

Social capital (SC) is an over and often inappropriately used concept, and is ill defined. Journal articles are increasingly appearing about the concept, whole books (for example Leenders & Gabbay 1999, Winter 2000), and a number of literature reviews are even being written on the ever-fashionable term (Adler & Kwon 2002, Woolcock 1998). Indeed a SC 'google' search returns over two million sites, with the concept being used to explain everything from lower levels of crime to better health (Aldridge, Halpern & Fitzpatrick 2002: 22-3). Furthermore, SC is increasingly cited in political circles (Portes & Landolt 1996:18) as a justification for less state involvement, espousing the argument that greater responsibility should be given to the community (Szretzer 2002, Giddens 2000, Fine 1999). There are three quite widely acknowledged (Fine 1999, Adler & Kwon 2002, Woolcock 1998) problems of the literature on SC: 1) there are problems surrounding the definition of the concept 2) it is considered to be a chaotic concept[7] 3) many authors believe that it neglects issues of power and conflict (Kulynych & Smith 2002, Fine 1999:16). This section attempts to reconcile these problems. The disparate conceptualisation of the term can be seen in Table 1.

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[6] The importance of non-economic relationships will be discussed in more detail in the next section.

[7] Because of the wide diffusion of use of the concept, some have argued that it is ineffective. However, there is, I believe, a need to distinguish reactionary and popular uses of the concept, from analytically 'forward-thinking' uses. Further, the term captures certain underlying processes and relationships which seem to be important for innovation.

Social capital is:

Author	Definition
Hanifan (1916:130)	'those tangible assets [that] count for most in the daily lives of people namely good will, fellowship, sympathy, and social intercourse among the individuals and families who make up a social unit'.
Jacobs (1961:138)	'networks…'.
Bourdieu (1986 :248)	'the aggregate of the actual or potential resources which are linked to possession of a durable network of more or less institutionalised relationships of mutual acquaintance and recognition' (1986:243) 'made up of social obligations ('connections'), which is convertible, in certain conditions, into economic capital and may be institutionalised in the form of a title of nobility'.
Coleman (1990:302)	'defined by its function. It is not a single entity, but a variety of different entities having two characteristics in common. They all consist of some aspect of social structure, and they facilitate certain actions of individuals who are within the structure'.
Schiff (1992:160)	'the set of elements of the social structure that affects relations among people and are inputs or arguments of the production and/or utility function'.
Putnam (1995:664)	'features of social life – networks, norms, and trust – that enable participants to act together more effectively to pursue shared objectives…Social capital, in short, refers to social connections and the attendant norms and trust'.
Fukuyama (1995:10)	'the ability of people to work together for common purposes in groups and organizations'. (1999:16) 'a set of informal values or norms shared among members of a group that permit cooperation among them'. (2000:3) 'an instantiated informal norm that promotes cooperation between two or more individuals'.
Knack & Keefer (1997:1251)	'trust, cooperative norms, and associations within groups'.
Woolcock (1998:155)	'the norms and networks facilitating collective action for mutual benefit' (1998:186) '(i) within their local communities; (ii) between local communities and groups with external and more extensive social connections to civil society; (iii) between civil society and macro-level institutions; and (iv) within corporate sector institutions'.
Lin (1999:471)	'resources accessed in social networks…focuses on the instrumental utility of such resources'.
Gargiulo & Benassi (1999:299)	'networks [that] facilitate access to information, resources, and opportunities…' that 'help actors to coordinate critical task interdependencies and to overcome the dilemmas of collective action'.
Serageldin & Grootaert (2000:44 & 46)	the 'certain degree of common cultural identifications, a sense of 'belonging' and shared behavioural norms' 'the social and political

	environment that enables nc ms to develop and shape social structure'.
Nooteboom (2000b:1)	''positional advantage' (Stoehorst 1997) and this entails both the creation and utilisation of networks...obligations, expectations, norms, and sanctions: they are based on networks and form the basis for networks'.
Burt (2000: 347)	'advantages that individuals or groups have because of their location in social structure'.
Adler & Kwon (2002: 17)	'the goodwill that is engendered by the fabric of social relations and that can be mobilized to facilitate action'.

Table 1: The disparate nature of the social capital definition: some selected definitions

From this growing literature, a number of themes can be identified in the definition of SC. The first is participation in networks: the notion of dense interlocking networks of relationships between a variety of actors (Burt 2000: 347, Lin 1999:471). The second is reciprocity: the notion of short-term altruism and long-term self interest – an actor may act for the benefit of others at a personal cost, with the general expectation that this kindness will be returned at some undefined point in time. Otherwise referred to as the 'favour bank', Elster (1989: 101, 111) gives the simplistic example of present giving. The third is trust: this entails a willingness to take risks in a social context based on a sense of confidence that others will act as expected and in mutually supportive ways (at a minimum that others do not intend harm) (Fukuyama 1995, Elster 1989: 100) The fourth theme is the institutional setting (norms, taboos, etcetera): they provide a form of informal social control that precludes the necessity for formal institutions (Knack & Keefer 1997:1251). The fifth is the stock or commons: networks, reciprocity, trust, and the institutional setting combine to form a strong community, with shared ownership over the SC. Finally, the sixth, pro-activity, is implicit in earlier themes, that is, a sense of individual and collective worth requires the active and willing engagement of citizens within a participative community. SC is not located in the individual actor or within the social structure, but in the space between (Coleman 1988). It is not the property of organisations, the market, or the state, though all can engage in its production. Inherent in the concept, is the notion of people as creators.

The disparate nature of the concept will not be addressed further in this paper for reasons of space. Suffice to say that many authors fail to explain the metaphorical, philosophical, and analytical origins of the concept, and choose to focus or emphasise certain aspects to support their respective cases. The above synthesis of both the wider literature and definitions shows that SC broadly has six dimensions: networks, reciprocity, trust, the formal and informal institutional settings, the commons, and proactivity. Further, all dimensions of SC need to be incorporated in SC analyses in order to reflect its actual scope.

Two further issues must be raised in the context of defining SC. Firstly, the usefulness of SC as a concept is often critiqued because of its 'dark side' (Putzel 1997: 939). That is, its exclusive nature – one group's SC may negatively impact on another group – cartels are often cited as an example in the business environment. It is misleading to say however, that a concept needs to be purely positive for it to be useful. For example, physical, human, financial, and natural capital can all be used in destructive ways (Fountain 1997), but most of the time they are used in constructive ways. Furthermore, it must be emphasised that at its core, SC is a relational, network concept (Burt 1992:12), and the 'capital' itself is not a property of individuals or the group, but is located in the space between (Fountain 1997). A number of authors have differentiated SC into two categories: ties that are strong or weak, bonding or bridging, internal or external, communal or linking (Granovetter 1973, 1983, Gittel & Vidal 1998, Putnam 2000). Specifically relating to the innovation process, it has been argued that bridging SC is important at the exploration stage, whereas bonding SC is important at the exploitation stage (Nooteboom 2000b & 2000c)[8]. Therefore, for the generation of innovation, and success over the long-term, it will be important even for exclusionary groups to establish external ties. If SC is conceptualised in this network and relational sense, then really cartels and other exclusivist groups are indicative of a lack of connectedness, that is, there is insufficient SC. The network would essentially have broken down, and greater levels of SC (connections) would need to be created.

Secondly, the use of the 'capital' metaphor in SC is also often critiqued (Dolfsma 2001, Kulynych & Smith 2002, Baron & Hannon 1994). Dolfsma (2001:73) argues that in light of the development of the concept, and considering its contemporary usage, 'capital' can be conceptualised as three things: 'tangible, external to the economic agent, that can moreover, be measured or valued in terms of money'. SC can be considered to be 'capital' in five major ways: a) it is an asset into which resources can be invested, and it can be expected that it will be possible to reap gains in the future, b) it is 'appropriable' in that it can be used for purposes other than its intended primary purpose (Coleman 1988), c) it is 'convertible' into other types of capital (Bourdieu 1985), d) it can replace or add to other resources (Adler & Kwon 2002: 21) e) it requires maintenance, however it depreciates with non-use or abuse, but unlike say physical capital, it does not depreciate with over-use, but would instead strengthen or even appreciate (Adler & Kwon 2002: 22).

SC is also considered to be very dissimilar to 'capital' for two fundamental reasons. Firstly, as discussed above, it is a relational concept. This is problematic for some authors because it cannot be exclusively owned and can be easily destroyed. However, the fact that SC requires a collective effort for its creation and durability is perhaps the concept's most illuminating characteristic.

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[8] See Granovetter's seminal 1973 work on 'the importance of weak ties', and also Granovetter 1983.

Furthermore, Adler & Kwon (2002:22) note that this feature is not unique, and that the efficacy of other network goods like for example communication devices, is also related to the number of users. SC is secondly considered to be fundamentally different from other forms of capital in that it is not tangible and is very difficult to measure[9] (Solow 1997, Fukuyama 1997, Abramovitz 1986:368). It must be said, however, that SC is a relatively new analytical tool, and that it took considerable time for a consensus to be reached on how to measure other forms of capital. Lucas (1988:35) discusses the problems of human capital measurement when the concept was in its embryonic stages: 'after two decades of research applications of human capital theory we have learned to see it in a wide variety of phenomena'. Much discussion about the measurement of SC has emphasised the inherently normative (and thus difficult to precisely measure) trust component (Fukuyama 1995, Knack & Keefer 1997, World Bank). Attempts to measure, the core network and relational component would be considerably easier and less contestable[10]. In terms of measurement, the fundamental point to note is that for a concept to be analytically useful, it does not have to be precisely and discretely measurable. SC is too intertwined and complex a concept for there to be a precise measurement. It is therefore perhaps only necessary to have broad indicators as to whether or not SC is strong or weak in a particular context; this point pertains particularly to the study of social capital and regional innovation.

Many scholars fundamentally reject usage of the capital metaphor not because they consider the term to be technically incorrect, rather on the basis that it is inappropriate for social processes[11] (Kulynych & Smith 2002, Fine 1999). However, the 'capital' in SC is illuminating because it implies both something that lives longer than the costs involved in its creation, and is necessary for other types of constructive pursuits. As long as one is explicit about the metaphorical meanings of the term, then there is nothing wrong with the use of the metaphor per se if use of it is illuminating. Moreover, the combination of 'social' plus 'capital' is compelling because it highlights both instances in which non-economic arrangements (both informal – norms, taboos, ethics - and formal –

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9 Indeed, the problematic measurement of SC has begun to dominate the literature surrounding SC.

10 For example, the European Commission releases statistics that reveal the number of small and medium sized enterprise that have actively engaged in cooperative measures in the preceding three years (available at www.innovating-regions.org/).

11 Metaphor is a phenomenon of language where what is said or written is not literally intended across language. It is an interactive process involving both principal and subsidiary subjects (Black 1962:40). Metaphor is to apply a word or phrase to an object or action in order to imply a resemblance (for example, 'the world is my oyster', 'truth is a woman'). Metaphors carry over a language process, and the two subjects then interact to create a new meaning, a meaning which cannot be achieved by some literal equivalent (Klamer & Leonard 1994:46). This is interesting to note, considering that a number of authors in critiquing the use of 'capital', have suggested the alternative use of capacity or capability. These terms are not, however, as illuminating, and have been critiqued on similar grounds to the capital metaphor (Dolfsma forthcoming: 2).

taxes, the rule of law - institutions) account for ensuing success, as well as the growth possibilities of successful 'collective action' (Fountain 1997). Furthermore, in the context of analysing SC in regional technological innovation, the capital metaphor is arguably entirely appropriate, because of the focus on positive economic outcomes. In this context, a conceptualisation of the social is being used to explain economic phenomena (that is, the social contribution to economic outcomes).

The importance of social capital for technological innovation

> Virtually every commercial transaction has within itself an element of trust, certainly any transaction conducted over a period of time. It can plausibly be argued that much of the economic backwardness in the world can be explained by the lack of mutual confidence (Arrow 1972:357).

There has been a long history of the intuition that 'society matters' for success in the economic arena (Winter 2000:19-20). It has been acknowledged in the contemporary literature that SC contributes to economic performance in a number of ways. However, it must be emphasised that the disparate definitional state of the SC literature carries on into the theoretical conjecture on the subject. This is problematic because all are talking of SC, but some are referring to the trust component, some to the network component, some only to horizontal associations, and some only to vertical associations. Furthermore, the object of analysis for a number of authors is the individual, whereas for others it is the firm, and some authors are discussing bonding SC over bridging SC. It is therefore difficult to identify the state of knowledge on the outcomes of SC, as there are many dimensions to the literature. An associated problem is that these different 'schools' of SC thought have now moved on to deal with the problems of measurement[12]. So authors like Putnam for example have focused on measuring SC in terms of participation in voluntary community organisations[13], while Knack & Keefer (1997) have focused on the World Values Survey[14]. Again SC research would benefit immensely from the concept being 'reigned in'.

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[12] For a discussion of these issues see Fukuyama 1997 and Solow 1997.

[13] Putnam et al (1993) argue that century old differences in SC have impacted on the success of the reforms of regional government. In another study, Putnam (1996) presents compelling evidence of the 'disappearance of civic America' measured through a decline in the participation in voluntary community organizations. The article provides a systematic analysis of possible explanations for the decline, and dismisses factors that are usually held accountable such as urbanisation and mobility, the civil rights movement, time and money, and the changing role of women. The main culprit according to Putnam is television (because of its time taking ability) as this seems to be the only factor that can account for the steady decline of SC since the 1940s and 1950s. There is a whole literature that has emerged directly critiquing Putnam's approach, arguing that Putnam is merely nostalgic for earlier times, and that while membership in traditional church and school organisations may be in decline, there are a whole variety of other groups that have emerged to address issues such as community environmentalism and AIDS.

[14] 'The question used to assess the level of trust in a society is: Generally speaking, would you say that most

Firstly, activities where actors depend to some extent on the future behaviour of other actors will possibly be achieved at a lower cost in high-SC contexts (Knack & Keefer 1997[15]). This is because future dependent transactions (such as the provision of goods and services with the promise of payment at some point in the future, or employment contracts that rely on the employee to carry out tasks that are difficult to monitor, or employer-funded training) will be achieved at a lower cost, because less resources will be directed into protection from exploitation. That is, less written contracts will be required, and those that are written will not specify every possible incident, and there will be overall less litigation. The resources that are being diverted from exploitation protection will be directed to more economically productive activities. Where SC is high, there is a possibility that there will be less reliance on formal sanctions to enforce agreements. This is particularly pertinent in the technological innovation process because in low SC environments, entrepreneurs are forced to direct considerable resources away from innovative activities to the monitoring of possible non-compliance by others. Where there is no formal financial institutional arrangement, investment can be facilitated through informal credit markets that depend on high levels of SC. This is especially important in the development context, where inadequate assets make it difficult to obtain finance through formal channels. It is also argued that government officials and thus government policies will have greater credibility in societies with higher levels of SC, and investment may thus be enhanced because the time horizon of agents will be extended from the short to the long term. This is because economic policy announcements on interest rates remaining low or the set up of the industrial relations and taxation systems are taken as reliable. An example of this can be seen in the Japanese system, where there is considerable autonomy of the bureaucracy, creating a degree of stability in the policy set-up. It is also said that higher levels of SC could enhance human capital, through increased benefits from more specialised and higher-level education.

Adler and Kwon (2002:17) discuss studies that have promoted SC as an explicatory factor, some of them relating to elements of the innovation process. SC is said to possibly: aid workers in finding jobs (Granovetter 1973, Lin & Dumin 1996, Lin, Ensel & Vaughn 1981), facilitate the exchange of resources between firms and enhance product innovation (Gabbay & Zuckerman 1998, Tsai & Ghosal 1998), assist intellectual capital creation and team success (Hargadon & Sutton 1997, Nahapiet & Ghosal 1998), provide greater skill pools for recruiting firms (Fernandez, Castilla, & Moore 2000), reduce the rate of employee turnover

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people can be trusted, or that you can't be too careful in dealing with people?' (Knack & Keefer 1997:1254). This is a most problematic method of measurement, and the reasons why will not be discussed here for reasons of space. Suffice to say for example: which 'people' should the survey respondents be thinking of? Friends, family, foe...

[15] The definition of SC used by Knack & Keefer focuses on the trust component, and this is what carries throughout this paragraph.

(Krackhardt & Hanson 1993), reduce firm failure rates (Pennings, Lee, & Van Witteloostuijn 1998), aid entrepreneurship and companies to get established (Chong & Gibbons 1997, Walker, Kogut, & Shan 1997), and enhance relations between suppliers and learning between firms (Uzzi 1997, Baker 1990, Kraatz 1998).

Morgan (1997), in a theoretical discussion, highlights the importance of SC for innovation at three levels: national, inter-firm, and intra-firm. At the national level, the importance of SC is emphasised because it smooths firm, science-base, finance, intermediate-institutional, and industry cooperation. At an inter-firm level, SC is said to facilitate 'integrated supply chains' which have historically delivered superior performance because of 'their problem-solving capacity' through an 'effective system of interactive learning'. At the intra-firm level, internal, bonding SC between for example research and development, engineering, and marketing units, is seen as important for innovation.

The fundamental importance of SC to technological innovation, however, lies in repeat cooperation. That is, for example, firms that have collaborated together successfully on a small scale, might be pushed to engage in riskier, larger scale projects. Through the development of trustworthy reputations, repeat interactions will arguably reinforce, enhance, and enlarge the existing network, being made to include other players in the wider political and economic environment. This highlights a conjecture about a productive feature of SC: its transitive nature (Fountain 1997). For example, James trusts Paul, and Paul trusts Jeremy, and it would follow that James will trust Jeremy.

As discussed in the previous section, in the new KBE 'knowledge is the most strategic resource and learning the most important process' (Lundvall & Johnson 1994). In this KBE context, with seemingly endless technology choices, Roos, Field, and Neely (1997) suggest that it has become almost impossible for single firms to remain fully technologically adept in their fields, and that the risks inherent in the investments required in doing so, would be too great to bear. This has highlighted the important role that supplier relationships are said to play.

This is even more so the case for the transfer of tacit knowledge because SC is said to increase the 'richness' of knowledge transfers. It supposedly gives meaning to information. This is illustrated in the example discussed in the previous section of Prussia 'catching-up' to Britain, where the key was in establishing links with British craftsmen who could transfer their know-how (Freeman & Soete 2000:298). SC is also beneficial to participating actors because it is believed that participants are able to learn about emerging opportunities and challenges more quickly than if they were insulated from the system. Problem solving and learning is also considered to be of a higher quality because various ideas will have been exchanged and debated between different nodes of the network. The idea here is that 'two heads are better than one' – actors in the system will view knowledge and information differently because of different

experience bases, and the solution will therefore be more appropriate and accurate. Conversely, actors that do not participate in networks, would (it is thought) be unable to engage in such productive 'brain-storming' and thus risk not only arriving at an inaccurate decision, but also wasteful duplication. In such an insular context, much of the resources that would otherwise be directed towards exploratory activities necessary for technological innovation would instead have to be diverted to protecting secrets. Regions and nations in which these types of firms predominate will, it is argued, find it difficult to innovate, especially in a rapidly changing environment.

Fountain (1997) discusses the example of biotechnology networks in the United States to illustrate the importance of SC for innovation. A study of cooperation in the most research-intensive section of the industry (therapeutics and diagnostics) found that the percentage of firms cooperating increased from 74 in 1990 to 86 in 1994. Furthermore, those firms with ties to other actors in the system (universities, research labs, other firms) tended to be both older and larger. Moreover, the successful firms of the study were all found to be extensive collaborators, with none of the non-participating firms turning out to be successful. These findings are particularly pronounced in the biotech sector because activities are highly interdisciplinary, and innovative activities are thus located mostly within the network as opposed to in one firm.

The aspects discussed above are just some of the reasons why SC is important for technological innovation. The fundamental point made in the literature, is that SC is more than a simple input – its nature is *multiplicative.* Therefore, in terms of its role in technological innovation and economic growth, its importance cannot be ranked equally next to physical or human capital for example. Nor can it simply be said that SC is of greater importance than physical or human capital. It is multiplicative in the sense that it will lie at the base of physical or human capital creation. For example, you and I cooperating, or two firms cooperating will create opportunities that, as separate entities could not even be imagined. SC will to a significant extent, determine what the existing forms or stocks of capital will be able to achieve.

The role of social capital in regional technological innovation and development

In a 'learning economy' the competitive advantage of firms and regions is based on innovation, and innovation processes are seen as socially and territorially embedded, interactive learning processes.

> The most effective scale at which to create competitive advantage is at the level of regional clusters. (Asheim 1996, Krugman 1993 in Green & O'Neill 1999:1).

The literature on national systems of innovation (dominated by the Lundvall et al led Aalborg school in Denmark) came about in the mid-1980s with the realisation that most innovation is concentrated within twenty advanced nations, each with distinctive characteristics (Niosi 2001:2). The literature on regional innovation systems has emerged in the 1990s, with the realisation that within the twenty nations, the bulk of the innovation / economic growth occurs within a few regions (the well known examples are Silicon Valley in the United States, Cambridge in the United Kingdom, Baden-Württemberg in Germany, and the 'Third Italy'[16]) (European Commission 2002:9). Indeed throughout history, successful regions like the aforementioned have built successful nations.

The processes of globalisation have created a paradox[17], in that the integration of the national and regional into the global, has actually emphasised the importance of the local or 'home market' for innovation and the creation of competitive advantage[18] (Patel & Pavitt 1994, Archibugi & Michie 1995, Lundvall et al 2001). Indeed it has been argued that the process occurring that we should be referring to is in fact '*glocalisation*' (Humbert 1993). The 'new' economy has reinforced this importance, as less-difficult and less-expensive access to information (through for example information and communication technologies) has reduced the value of public / codified knowledge, and increased the value of tacit knowledge (Wolfe 2002:5).

The regional level is considered critical for the transfer of tacit knowledge for three main reasons: 1) learning through interaction is encouraged, because spatial immediacy supposedly frequents interaction on a close level, the kind of interaction that is said to enable learning 2) a 'common regional culture' is said to be shared by firms in regions, which is said to facilitate the 'social learning' process, bestowing critical advantages to firms engaged in such networks (Patel & Pavitt 1994). 3) The interaction is furthermore supported by the regional institutional structure, which in turn governs the way in which firms of the region will behave (Wolfe 2002:6). This third point is really the critical one. The literature linking the public policy setting to social capital argues that social capital can be consciously created and is not simply an inadvertent spin-off of other actions (see for example Levi 1998, Tarrow 1996). However, many of these institutional arguments of SC have not particularised which institutions matter in the creation of SC, and it is clear that a plethora of institutions with many

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16 This refers to north-east and central Italy, renowned for its many industrial districts based predominantly around manufacturing sectors (European Commission 2002:9)

17 Storper (1995) calls this 'the principle dilemma' of economic geography.

18 The literature on globalisation through authors like Kenichi Ohmae has claimed that the extensive diffusion of technology and knowledge and its easy accessibility, has rendered both national boundaries and capacities unimportant. Evidence has however shown that the bulk of technology flows is between 'rich' or OECD countries (Freeman & Hagedoorn 1993). Furthermore, the core technological innovation activities of multi-nationals still largely occur in the base country (Morgan 1997). It can therefore be said that globalisation has largely been overstated (Cassiolato & Lastres 1999:5-6).

combinations exist. Rothstein & Stolle (2002) differentiate between institutions that represent and institutions that implement, arguing that the institutions that matter in the creation of 'generalized trust' (their definition of SC) are the ones that implement. This is because a major role for representative institutions is to be partisan, and thus people who support the prevailing ideology will have trust in the representative institutions, and those that do not, will not. On the other hand, implementation institutions (law and order, health care, education, social welfare agencies) can have a great impact on SC for two main reasons. Firstly, this type of institution is usually more permanent in nature and can thus exercise significant influence on SC in the regional context. Secondly, because contact with these institutions is most frequent, they make known the principles and norms of the political culture, which in turn shapes people's and firm's belief systems. What is important here is not simply whether the institution solely represents the particular citizen or firm, but whether the standards of 'universalism, equality before the law, impartiality and a reasonable degree of efficiency' (Rothstein & Stolle 2002: 13) are upheld.

There is also a growing body of work that emphasises the fundamentally geographical nature of innovation[19] (Morgan 1997, Amin & Thrift 1995, Saxenian 1994, Storper 1995). This is because a number of regional assets including the store of embedded knowledge, learning capacity, as well as entrepreneurial approaches, are considered to be of fundamental consequence to the innovation capacity and success of firms (European Commission 2002:9). Patel and Pavitt (1994) further argue that the spatial nearness allows decisions to be made quickly, and the proximity is also thought to aid the collection of what Rosenberg (1976) calls 'grubby and pedestrian forms of knowledge'.[20] Both of the aforementioned processes are considered to be especially important in the contexts of innovation and the 'new' economy. Storper (1995) unites all of these points, calling the region 'a key necessary element in the 'supply architecture' of learning and innovation'. Regional clustering is thus seen as the answer to 'the globalisation trap' (Steiner 1997, Lagendijk 2000: 165, European Commission 2002:9), because it is superior for the overall stimulation of innovation (Asheim & Isaksen 2000).

However, we must be careful not to overstate the role that SC plays in the regional technological innovation context. As discussed in section two, it has been argued that bridging SC is important at the exploration stage, whereas

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[19] The study of regional innovation is said to be merging three disciplines: the regional innovation systems approach, as briefly discussed above, the economic geography approach, and also the cluster development approach (Morgan 1997, Wolfe 2002:2-3).

[20] Rosenberg (1976) argues that 'grubby' forms of knowledge (such as engineering), which are fundamentally important in the innovation process, are regarded as second-rate to more pure scientific forms of knowledge in the West. In contrast to this, Japanese authors such as Nonaka and Takeuchi (1994) have argued that Japanese firms take very different views on knowledge than in the West, seeing 'grubby' and tacit knowledge of utmost importance to the innovation process.

bonding SC is important at the exploitation stage (Nooteboom 2000b & 2000c).[21] Therefore, for the generation of technological innovation, and success over the long-term, it will be important that there is both communal SC and external SC. Without both of these kinds of SC, regional success will only be a short-term phenomenon. Furthermore, it would be naïve to say that SC is the only regional development resource necessary for success. Indeed a policy recommendation that emphasises only the importance of regional clustering may have devastating ramifications if there are not reasonable stocks of physical, financial, and human capital, for example. It would be patronising for those already at advanced developmental levels to pretend that they achieved success only in this way, and this would be the flawed DIY approach that we have seen in cases in the Third World. In reality, it is important for policy makers to realise that yes SC is important, but that it must be used and prescribed in conjunction with a wide range of factors. Essentially it is the glue that holds the structure together – it does not replace other resources.

Conclusion

This paper has attempted to address deficiencies in the existing literature on SC in the context of regional technological innovation and development by identifying key conceptual and methodological principles and by trying to understand the interactions between the concepts of social capital and innovation. If the spin-off themes are allowed to dominate the entire social capital literature, then we risk losing important insights from a fascinating concept. Thus future social capital research needs to move beyond the pedantry of precise definitions and measurement, by realising that such a thing as **social capital does exist**, and that it is a combination of reciprocity, networks, trust, the institutional setting, the commons, and pro-activity. Further, because social capital is a contextual concept, it needs to be acknowledged that precise measurement is not really possible. Two points need to be noted here: firstly, it is reflective of our times that only tangible, precisely measurable things are considered to be of importance. One only needs to take stock of one's life, however, to realise that this is indeed not the case. Secondly, the social capital literature emerged precisely to highlight the importance of intangibles over traditional units of analysis. Why then, is the concept being caught up in tangible concept issues (debate continues to rage even over the measurement of physical capital for example) when broad indicators of social capital will suffice. Thus future empirical research on social capital and innovation should focus on the dynamic and explanatory level, specifically through in-depth case studies and interviews for example.

This paper has also shown that at the other end of the spectrum we need to be very careful in hailing social capital as the answer to all the complexities of

[21] See Granovetter's seminal 1973 work on 'the importance of weak ties', and also Granovetter 1983.

modern life. Proclaiming social capital as the blanket solution is far too crude, and misses the fact that social capital, by nature, is exclusive and thus will inevitably inhibit factors that are necessary for success. Broad-sweeping claims such as these, risk devastating policy prescriptions at all levels. Therefore, future research again needs to analyse the specific mechanisms though which social capital gives rise to outcomes. Yes social capital does exist, and yes it is important for regional technological innovation. However, social capital can also be a hindrance for regional technological innovation, and cannot replace other important regional development resources. Essentially, the concept needs to be taken stock of: we need to see both the wood and the trees.

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Weak Ties in Networked Communities

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Abstract. Communities with high levels of social capital are likely to have a higher quality of life than communities with low social capital (Coleman, 1988, 1990; Putnam, 1993, 2000). This is due to the greater ability of such communities to organize and mobilize effectively for collective action because they have high levels of social trust, social networks, and well-established norms of mutuality (the major features of social capital). Communities with 'bridging' social capital (weak ties across groups) as well as 'bonding' social capital (strong ties within groups) are the most effective in organizing for collective action (Granovetter, 1973; Putnam, 2000). People who belong to multiple groups act as bridging ties Simmel [1908] 1950; Wellman, 1988). When people with bridging ties use communication media, such as the Internet, they enhance their capability to educate community members, and organize, as needed, for collective action. This paper summarizes evidence from stratified household survey data in Blacksbûrg, Virginia showing that people with weak (bridging) ties across groups have higher levels of community involvement, civic interest and collective efficacy than people without bridging ties to groups. Moreover, heavy Internet users with bridging ties have higher social engagement, use the Internet for social purposes, and have been attending more local meetings and events since going online than heavy Internet users with no bridging ties. These findings may suggest that the Internet – in the hands of bridging individuals -- is a tool for maintaining social relations, information exchange, and increasing face-to-face interaction, all of which help to build both bonding and bridging social capital in communities.

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Social Groups and Weak Ties

We examine differences in community involvement and collective efficacy that may be associated with the strength of social ties and Internet use. We examine these outcomes in the town of Blacksburg, Virginia, home of the community computer network known as the Blacksburg Electronic Village (BEV). The BEV is a well-established community network serving the residents of the university town of Blacksburg (population 47,000), and surrounding Montgomery County (population 35,000) since 1993.

Social networks and groups are maintained through communication among members, whether in face-to-face situations or facilitated by media, such as, letters, telephone calls, or the Internet. Wellman (2001) argues that when computer networks, such as the Internet, link people as well as machines, they become social networks. The Internet, like other forms of communication, helps people maintain contact with members of their social network or group, cultivate ties and garner aid and resources, including information. Social networks and groups with strong ties among members have what Putnam (2000) refers to as 'bonding' social capital. Typically, a person's social network is comprised of their friends, family and acquaintances, whether proximal or distant. A person's social groups are those formal and informal organizations or collections of friends and/or acquaintances that participate in common activities or tasks on a regular basis through in a common affiliation (church, soccer league, and other voluntary associations).

Social networks and groups help to build trust among members. Social trust, also a feature of social capital, increases as people get to know each other, learn who is trustworthy, and experience things together through voluntary associations and clubs, such as the Boy Scouts, church, the PTA, and informal group activities). Williams (1988, p. 8) and Newton (1997, p. 578) distinguish between "thin" trust and "thick" trust in social networks. In small face-to-face communities (tribes, isolated islands, rural peripheries), "thick" trust is generated by intensive, daily contact between people. These tend to be socially homogeneous and exclusive communities, able to exercise social sanctions necessary to reinforce thick trust (Coleman 1988, pp. 105-108). One could also expect to find thick trust within close-knit organizations, such as small churches or within gated communities.

Thin trust is less personal, based on indirect, secondary social relations. It is the product of what Granovetter (1973) distinguishes as weak ties among members, and Putnam (2000) calls 'bridging' social capital. Weak ties link members of different social groups to help integrate diverse groups into a larger social setting, such as a geographic community. Thin trust is also the basis for social integration in modern, large-scale society (Newton 1997, p. 579). Both bonding and bridging types of social capital are important for sustaining healthy

communities (Putnam 2000). Bonding capital creates and continues the connections that keep individual community groups viable. Bridging capital allows connections between otherwise disconnected groups or civic organizations. Bridging ties facilitate the exchange of information between distinct groups, and help to expedite the flow of ideas among groups. As such, they are important to the process of educating the community as a whole, and in organizing or mobilizing for collective action.

The strength of a tie is a combination of the amount of time, emotional intensity, intimacy (mutual confiding), and reciprocal services that characterize the tie (Berkowitz, 1982; Fischer, 1977; Granovetter, 1973; Marsden and Lin, 1982). Strong ties are characterized by (Wellman, 1992, pg. 211-212):

- A sense of the relationship being intimate and special, with a voluntary investment in the tie and a desire for companionship with the tie partner;
- An interest in being together as much as possible through frequent interactions in multiple social contexts over a long period;
- A sense of mutuality in the relationship, with the partner's needs known and supported.

Conversely, weak ties are more instrumental than strong ties – providing informational resources rather than support and exchange of confidences (Wellman, 1992). Weak ties also provide increased reach for an individual's work, such as, promotion opportunities, professional recognition, and social integration (Haythornthwaite, 2001). People with whom the respondent socializes exclusively at school or at work or through a common group affiliation would be considered weak ties, as would be people whom the respondent might ask to be a reference when they apply to a job.

For a community to have many weak ties that bridge, there must be several distinct ways or contexts in which people may form them, such as a rich organizational life, with most people working in the area (Granovetter, 1973; Keyes, 1969). Rich organizational life provides many opportunities for people to serve as weak ties across diverse groups. Simmel ([1908] 1971) is credited with the classic insight that, in essence, intergroup networks simultaneously connect persons and institutions (Wellman and Berkowitz, 1988; Wolf, 1950). Two persons may be connected through an interpersonal tie. But a single person may also connect two groups when he or she is a member of both. Such joint memberships form group-to-group ties that indirectly connect all persons in each separate group. Thus, a person's membership in more than one organization allows them to serve as a weak tie between groups. Leaders of organizations are particularly well suited to serving as weak ties, as they are even more likely than members to carry information from one group to another as part of their organizational duty and role, as long as the information is not of interest only to one group.

Granovetter (1973) argues that if a community consists largely of isolated silo-like cliques, each person bonds to others within his own clique, but not to others outside. Involvement in widely dispersed and instrumental networks provides greater access to resources than does involvement in highly dense and intimate ones. Without bridging ties to different groups, cliques lack the interpersonal ties that help to spread information or innovation conveyed by mass media and other sources, including newspapers, TV/radio, and Internet postings. Diffusion and communication research have shown that while mass media make most people aware of information, new ideas or 'nascent mobilization,' people rarely act on such information unless it is also transmitted through personal ties (Katz and Lazasfeld, 1955; Rogers, 1962.) Thus, the more local bridges in a community and the greater their degree, the more cohesive the community and the more capable of acting in concert (Granovetter, 1973).

Weak Ties and Internet Use

There is preliminary evidence that the Internet helps to increase the number of weak ties across social groups in communities with high penetration of the Internet (Hampton, forthcoming, 2003; Kavanaugh, 2002). Prior studies in Blacksburg indicate that individuals who are members of several social groups are using the Internet in ways that support both bonding and bridging types of social capital.[1] Interviews conducted between 1996 and 1999 with leaders in the civic community,[2] the religious community,[3] and the arts community[4] noted the importance of Internet services (organizational web site, listserv, and/or email) in strengthening social ties and information exchange within their organization. Several leaders also noted how the Internet was helping to strengthen weak ties between their group and another group or organization in the community. For example, the president of the Arts Council, an umbrella organization of many different artists and groups dispersed across three nearby towns and two adjoining counties, has seen members of previously disparate arts groups linked together through weak ties:

> It used to be small groups like the three towns I talked about...Each one of them had a group of people that talked to each other, but not between the

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1 Federico Casalegno, doctoral candidate at the Sorbonne, Paris at the time, collaborated on the design and conduct of interviews of community leaders in 1998, and on interviews with BEV Seniors in 1996. The author's research assistant, Evonne Noble, assisted with interviews of BEV Seniors and community leaders in 1999.

2 Specifically, these are: town manager, the Finance Director for town government, a member of the Board of Supervisors for the county, and the president of the League of Women Voters.

3 Representing a Presbyterian Church, a Baptist Church, a Unitarian Universalist meeting, the Islamic Center of Blacksburg, and the Jewish Community Center.

4 Specifically, the president of New River Arts Council, an umbrella organization representing local performance and graphic arts groups dispersed throughout two adjoining counties.

> three towns. Now all three towns talk to each other. They opened up new lines of communication. Those people then often talk to people in Blacksburg or Christiansburg. And we have now some connections out to Pulaski or Floyd County where they never used to talk very much before.

The arts council web site and listserv are new lines of communication that help individuals act as weak ties between the different arts groups, that are reinforced by face-to-face interaction at art gatherings. In another case, the web master and listserv manager (and trustee) of the local Unitarian Universalist meeting, mentioned that the web site of the Unitarians links to another community organization with similar values and interests. He said the link to the other organization's web pages "allows us to be able to interconnect with them in a way to make us aware of their activities." Here, not only are individuals, such as the web master, able to act as links between two groups, sharing information, but the mirrored web links are themselves 'weak' ties across the two different social groups in the community.

Hampton (2002) argues that computer mediated communication at the local level provides an opportunity for local social interaction that facilitates the formation of weak social ties and community involvement. In a study of the wired suburb of Toronto known as Netville, Hampton (2003) shows that residents of a networked neighborhood were able to organize and mobilize collectively, in large part due to the weak ties among them. He measured the strength of social ties by whether the respondent classified the neighbor as someone whom they recognized but did not talk with, someone they talked with but did not visit, or someone they visited. Hampton and several other researchers emphasize that in a situation where computer networking facilitates knowledge sharing, weak ties may be more important for collective action than strong ties (Kraut, et al, 1996; Nie 2001). In this study, we use collective efficacy as an indicator of respondents' beliefs and perceptions regarding the community's potential for organizing and mobilizing for collective action.

Collective Efficacy and Internet Use

According to Bandura (2000),

> people's shared beliefs in their collective efficacy influence the types of futures they seek to achieve through collective action, how well they use their resources, how much effort they put into their group endeavor, their staying power when collective efforts fail to produce quick results or meet forcible opposition, and their vulnerability to the discouragement that can beset people taking on tough social problems. (p. 76)

Bandura (2001) suggested that new electronic technologies provide "vast opportunities for people to bring their influence to bear" on "collective civic action" (p. 17); however, he warned that "perceived efficacy will shape how the internet changes the face of social activism" (2002 , p. 11). He has suggested

ready access to communication technologies will not necessarily enlist active participation unless people believe that they can achieve desired results by this means. Strong personal efficacy and collective efficacy are key determinants of active participation. While we do not have measures of personal efficacy in this study, we do have measures of collective efficacy that we tested and report in this paper.

We expect that people who serve as weak ties or bridges between distinct local groups and who use the Internet for communication and information exchange (either with the organization or in general) are better positioned to expedite information distribution, collective organization or action in their communities than non-bridges who use the Internet. When people are effective in attempts to influence outcomes in their community, their sense of collective efficacy rises or is reinforced. Collective efficacy is often associated with higher education and social status; however, it has also been found to flourish among lower socio-economic strata. For example, perception of collective efficacy and sense of civic responsibility explained between 23% and 25% of the variance in grassroots neighborhood participation in New York City (Perkins, Brown, & Taylor, 1996). Defining collective efficacy as a composite of informal social control, cohesion, and trust, Sampson, Raudenbush, & Earls (1997) suggested that "collective efficacy of residents is a critical means by which urban neighborhoods inhibit the occurrence of personal violence, without regard to the demographic composition of the population" (p. 919). The researchers found it "a robust predictor of lower rates of violence" (p. 923). Hence, some research has shown that collective efficacy can both (a) help citizens to self-govern and (b) increase citizen's participation in governance, regardless of SES.

Methodology

As part of a larger study of community and the Internet in Blacksburg and Montgomery County, we administered a survey questionnaire to a stratified random sample of 100 households. Survey instruments are useful mechanisms for capturing quantitative data in the form of self-reported traits, attitudes, beliefs, and behaviors. We stratified households on the basis of education level, Internet use, and location (town or county). Once a household accepted to be in the study, we had each member complete a survey questionnaire (younger members completed a modified questionnaire which is not included in this paper). We also conducted group interviews (with all members of a given household forming each group) with a subset of households. Finally, we configured the network connections of a subset of households (all that were possible) so that we could monitor household web use (hits, time of use, etc.) and email exchange (headers only). Focusing at the household level allows us to capture interaction and usage patterns related to Internet use in the home. This paper reports findings from only

the survey, although we consulted interview data where clarification to survey data was useful.

The adult survey questionnaire asked respondents about their community involvement, organizational memberships, informal group participation, Internet use, social circles, collective efficacy, psychological attributes, significant life changes, and basic demographics. The questions of greatest relevance to the investigation reported in this paper are those regarding group membership and participation, Internet use, community involvement and collective efficacy. Our survey instrument has six research themes: community involvement, activities and interests, collective efficacy, Internet behavior and effects, social networks, and psychological scales. These six themes define the main sections of the survey, with the addition of demographic data. To the greatest extent possible questions were drawn from existing survey instruments, particularly the HomeNet study (Kraut 1996, 2002) and BEV survey instruments. In this paper we examine relationships among items in the sections on community involvement, activities and interests, collective efficacy, and Internet use. We also looked at demographic and psychological factors (life changes, extroversion). Constructs and variables that were tested, but not significant, are not included in the results, but are included in the discussion section of the paper.

The section of the survey on community involvement organizes questions according to three different topics: community involvement, community attachment, and local organization affiliation and roles (leader, member, attendee). It includes a set of community involvement measures by Rothenbuhler (1986; Shepherd and Rothenbuhler, 2001) on how frequently respondents keep up with local news, get together with others who know what's going on in the community, have ideas for changing things in the community, and work to bring about change in the community. The section on activities and interests uses a frequency scale (ranging from never or almost never to several times a day) over the last six months for questions, such as spending time with friends, taking a class outside of school, discussing politics, watching TV.

We created a typology aggregating variables related to common constructs (community involvement, activities and interests, Internet use). We ran correlations on the variables for each construct and conducted reliability tests. We sought to obtain constructs comprised of one factor, with reliabilities (indicated by Cronbach alpha) greater than 0.7. We developed constructs for all the main items in the survey. We tested all the constructs and variables in the study for this paper, with the exception of social circles and household communication patterns. Among the key constructs tested for this paper are:

- Informed, e.g., keep up with local news, have ideas for change in the community;

- Activism, e.g., work to bring about change in the local community, being active relative to others;
- Belonging, e.g., feeling part of several groups or organizations, having a group of friends;
- Community Attachment, e.g., how happy to live in the community, willingness to move to another community;
- Participation, e.g., level of involvement in local events, activities;
- Trust, e.g., feeling most people can be trusted, feeling people will take advantage of you, (reversed);
- Civic interest, e.g., taking a class outside school or work, helping a neighbor, keeping up to date on local events, voting in elections;
- Political interest, e.g., discussing politics, writing or calling elected officials, working for a political party, attending rallies or speeches; and
- Internet use for political purposes, e.g., online versions of political activity, including emailing government officials, finding political information online, discussing politics online.

For more detail and background on the survey questions and constructs and the statistical analyses please see the project web site (http://epic.cs.vt.edu).

The Internet use measures include amount of use (number of hours on an typical day) and the type and frequency of online activity in the past six months (e.g., get news, play games, communicate with friends and family, bank online). This set of questions is adapted from the HomeNet survey instrument to emphasize local versus distant activities and active versus passive behavior. The frequency scale ranges from 'almost never' to 'several times a day.' We also asked about respondents' attitudes toward computers and the Internet (Likert scale of agreement with statements about the helpfulness of the Internet for a variety of purposes, such as, political activities, civic affairs, social engagement, shopping). Questions developed by Georgia Tech (1995) and adapted by Kavanaugh in previous BEV surveys provide a third set of questions that measure respondents' self perception of changes in involvement since getting on the Internet. We asked respondents whether, since getting on the Internet, are they less, equally or more involved in the local community, local people, non-local people, a diversity of local and non-local people, and local and non-local issues of interest.

To investigate respondents' participation in local groups and organizations, we examined the number of organizational affiliations and the level of participation (non-participant, attendee or member, leader). First, we divided respondents into two main categories (bridges and non-bridges) who are, respectively: 1) members or leaders in two or more organizations and 2) members or leaders in one or no organizations, including non-participants. We further subdivided the bridges into leader bridges and member bridges, and compared these with the subdivision of

non-bridges category into non-bridges affiliated with one organization, and non-bridges affiliated with no organization. We conducted independent samples t-tests on these two main categories, and one-way ANOVAs on the four subcategories, with the main study variables of community involvement, interests and activities, Internet use and collective efficacy and its dimensions (active cooperation, social services, and economic development).

We examined the use of various modes of communication by the organizations to which respondents were affiliated, including face-to-face, telephone, email, email discussion list, and online bulletin board. We isolated and checked survey cases to determine whether leader bridges and member bridges indicated that at least two of the organizations with which they were affiliated also used the Internet to communicate or exchange information among members.

In addition to independent samples t tests and one-way ANOVA tests on the variables noted above, we investigated differences in Internet use and effects among bridges versus non-bridges by dividing the sample into bridges that are heavy versus light Internet users and non-bridges who are heavy versus light Internet users. Drawing from Nie (2001), we divided amount of Internet use into heavy users, measured as more than one and a half hours per day, and light Internet users (zero to one and a half hours per day). We conducted univariate ANOVA tests on each of the study variables (noted above) comparing heavy versus light usage by bridges versus non-bridges.

The community collective efficacy measure is comprised of a 13-item scale. Each item pertained to a key area of community challenge and/or achievement and a specified obstacle (see Table 1). Directions asked participants to rate the community's ability to achieve each goal on a five-point scale: (1) not well at all, (2) not too well, (3) somewhat well, (4) pretty well, and (5) very well.

1.	TOURISM: Our community can present itself in ways that increase tourism.
2.	IMPROVE ROADS: We can greatly improve the roads in Blacksburg and Montgomery. County, even when there is opposition within the community.
3.	QLIFE: I am convinced that we can improve the quality of life in the community, even when resources are limited or become scarce.
4.	QEDUC: Our community can greatly improve the quality of education in Montgomery County without help from the Commonwealth of Virginia
5.	SETBACKS: As a community, we can handle mistakes and setbacks without getting discouraged.
6.	COOP-FACILITIES: Our community can cooperate in the face of difficulties to improve the quality of community facilities.
7.	VISION: I am confident that we can be united in the community vision we present to outsiders.
8.	COMMON GOALS: Despite our differences, we can commit ourselves to common community goals.
9.	WORK TOGETHER: The people of our community can continue to work together, even when it requires a great deal of effort.
10.	RESOLVE CRISES: We can resolve crises in the community without any negative aftereffects.

11.	FAIR LAWS: Our community can enact fair laws, even when there is disagreement among people.
12.	RESOURCE-JOBS: I am confident that our community can create adequate resources to develop new jobs despite changes in the economy.
13.	SENIOR SERVICES: Our community can greatly improve services for senior citizens in Blacksburg and Montgomery County without help from the Commonwealth of Virginia

Table 1: The 13 Items Within the Community Collective Efficacy Scale.

We used factor analysis and structure equation modeling to investigate the underlying structure of collective efficacy (Carroll & Reese, 2003). Data indicate a general construct of collective efficacy, composed of three dimensions or factors (see Figure 1). The first, Active Cooperation (Cronbach $\alpha = .86$), is composed of seven indicators. In general, this group of indicators speaks to a perception of the community's ability to cooperate in the face of difficulties.

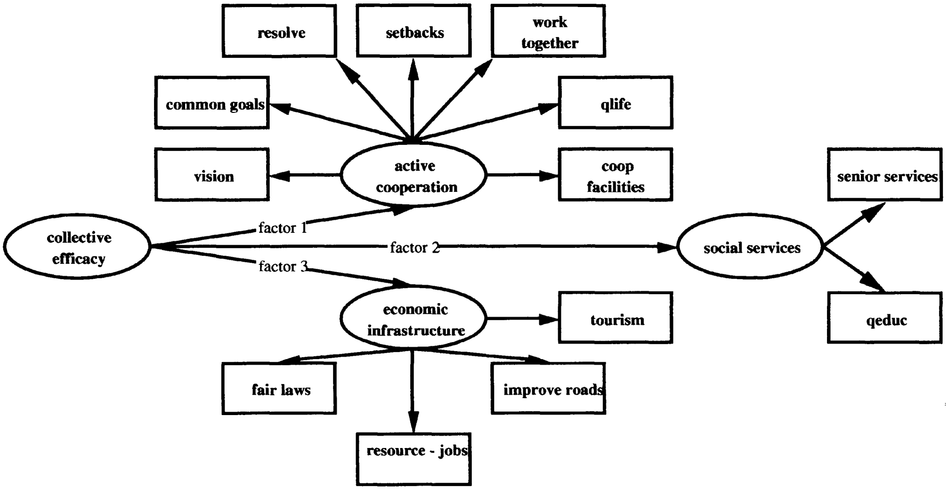

Figure 1: Model of Collective Efficacy Construct, Three Dimensions (Factors), and 13 Indicators

The second factor is Social Services (Cronbach $\alpha = .77$), composed of items involving perception of the community's ability to provide senior services and education. The third factor measures an individual's perception of the community's ability to maintain a strong Economic Infrastructure (Cronbach $\alpha =$ .63) through fair laws, creating conditions fostering a strong job market, roads and tourism.

Results

Group Affiliation and Weak Ties

For the total sample in our study, the average number of local organizations with which respondents are affiliated is 2.4 groups. This is just above most other studies, which show two local affiliations to be about average (Edwards, 1973, Perkins, et al, 1996). Typically, church is one of the most common affiliations, and this is the case in our study, as well.

Just under half of respondents are classified as bridges (48%, N=75); that is, they are either a member of two or more groups (N=52), or a leader of two or more organizations (N=23) (see Table 2). Just over half of respondents are categorized as a 'non- bridge (52%, N=83);' that is, they are not members of any group (N=39), or they are members of only one group (N=44). There are 7 cases in which an individual is a member of at least one organization and a leader in at least another. Since this is such a small group, we included them together with the member bridges.

Bridge	48%	N=75	Leader Bridge: 2+ groups	N=23	14%
			Member Bridge: 2+ groups	N=52	33%
Non-Bridge	52%	N=83	Affiliation: 1 group	N=44	25%
			No affiliation	N=39	28%

Table 2: Bridges and Non-bridges: Descriptives

As shown above, a minority (14%, N=23) are leaders in two or more organizations. The majority of respondents (57%, N=90) are not leaders in any organization; and almost a third (29%, N=45) are leaders in only one organization. Leader bridges report a higher number of weak ties (acquaintances) than both member bridges and non-bridges (approaching signifance, $F(2,148)=2.73$, $p=.069$), and they email a higher percentage of acquaintances than either member bridges or non-bridges do. Member bridges also have a higher number of weak ties than non-bridges, and email a higher percentage of acquaintances than non-bridges. Nonetheless, apart from leader bridges' number of acquaintances, one-way ANOVA tests show the rest of these differences are not significant.

First, we consider the differences in the two main categories (bridges vs. non-bridges) using independent samples *t* tests across demographics, interests and activities, psychological factors, community involvement, collective efficacy measures, and Internet use. Being online also appears to have different effects on bridges and non-bridges on several measures of community. Then we consider

differences between the sub-categories of leaders bridges (LB), member bridges (MB), non-bridges with a single group affiliation (NB1) and non-bridges with zero affiliations (NB0) using one-way ANOVA.

The first analysis -- the comparison of the two main categories (bridges versus non-bridges) -- is shown in Table 3. Bridges are more extroverted, better educated, more informed and more activist than non-bridges. They have a greater sense of group belonging and higher levels of trust, community attachment, and community participation than non-bridges. They are more interested in civic life and political affairs. They have greater confidence in the community's ability to work together to solve common problems (measured by collective efficacy and its three factors -- active cooperation, social services, and economic development) than non-bridges. They use the Internet for political purposes and civic activities more than non-bridges. Since going online, they have become more involved in the community, more involved in local issues that interest them, and more connected to local people. Since going online, they have been attending more meetings and events of local groups that interest them.

Construct	Bridge Mean	Non-bridge Mean
Education ‡ **	3.5	3.2
Household Income**	6.0	5.0
Extroversion**	3.4	3.2
Informed ‡ *	3.7	3.4
Activism**	2.9	2.2
Belonging*	3.5	3.2
Community attachment*	3.9	3.5
Trust ‡ **	3.9	3.6
Participation**	3.2	2.5
Computer interest ‡ *	4.2	3.7
Political interest ‡ *	1.5	1.2
Civic interest ‡**	2.8	2.2
Online political activity ‡ *	1.5	1.3
Collective Efficacy (CE) **	3.4	3.1
Active Cooperation (CE Factor 1) **	3.6	3.2
Social Services (CE Factor 2) *	3.0	2.7
Economic Development (CE Factor 3)*	3.4	3.1
Since online, involvement in local issues of interest ‡ *	2.2	2.0
Since online, connected with local people ‡ **	2.3	2.0
Since online, involvement in local community ‡ **	2.3	2.0
Since online, attendance at local meetings and events**	2.2	1.9

** $p<.01$, * $p<.05$

‡ Statistics corrected where equal variances not assumed

Table 3: Bridges and Non-bridges: Attributes, Interests, Collective Efficacy, and the Internet

Some of the differences shown above between bridges and non-bridges disappear when we test for differences among the four sub-categories. The next three tables consider these differences, by dividing them into attributes and community measures (Table 4), collective efficacy (Table 5) and Internet use and effects (Table 6). Considering attributes and characteristics using one-way ANOVA tests (Table 4), we see significant differences between these four groups on socioeconomic status and on the constructs of Informed, Activism, Belonging, Community Attachment, Participation and Civic Interest. The differences on measures of attributes and characteristics that disappear when we divide the four sub-categories are: trust and extroversion. The leader bridges appear to be responsible for most of the differences between bridges and non-bridges.

	Leader Bridge (LB) Mean	Member Bridge (MB) Mean	Non-bridge 1 (NB1) Mean	Non-bridge 0 (NBO) Mean
Education*	5.57^{NBO}	5.23	4.90	4.52^{LB}
Household Income**	5.95^{NBO}	6.0^{NBO}	5.26	$4.70^{LB, MB}$
Informed*	3.90^{NB1}	3.63	3.4^{LB}	3.46
Activism**	$3.18^{NB1, NBO}$	$2.78^{NB1, NBO}$	$2.3^{LB, MB}$	$2.1^{LB, MB}$
Community Attachment*	4.0^{NB1}	3.75	3.49^{LB}	3.53
Participation**	$3.51^{MB, NB1, NBO}$	$3.12^{LB, NB1, NBO}$	$2.65^{LB, MB}$	$2.41^{LB, MB}$
Civic Interest**	$3.13^{MB, NB1, NBO}$	$2.71^{LB, NB1, NBO}$	$2.33^{LB, MB}$	$2.1^{LB, MB}$

**p<.01, *p<.05; Tukey post hoc test used on all variables above, since equal variances assumed

Table 4: Bridges versus Non-Bridges on Attributes and Community Measures

Leader bridges are different from the subcategory of non-bridges on most measures shown in Table 4 above except socioeconomic status and community attachment (where they are different from non-bridges with no group affiliations) and being informed (where they are different from non-bridges with one group affiliation). Leader bridges have higher levels of participation and civic interest than all other subcategories (both subcategories of non-bridges *and* the subcategory of member bridges). Member bridges have higher levels of household income than non-bridges with no group affiliation, are more active, and have higher levels of participation and civic interest than non-bridges in both sub-categories.

Weak Ties and Collective Efficacy

Leader bridges have greater confidence in the community's ability to work together to solve common problems (measured by collective efficacy and three dimensions -- active cooperation, social services, and economic development) than non-bridges with no group affiliation (Table 5). Leader bridges are higher than non-bridges with one affiliation on collective efficacy and the economic development component. Member bridges are higher than non-bridges with no group affiliation on collective efficacy and active cooperation.

	Leader Bridge (LB) Mean	Member Bridge (MB) Mean	Non-bridge 1 (NB1) Mean	Non-bridge 0 (NB0) Mean
Collective Efficacy**	$3.55^{NB1, NB0}$	3.35^{NB0}	3.18^{LB}	$3.05^{LB, MB}$
Active Cooperation**	3.61^{NB0}	3.53^{NB0}	3.33	$3.17^{LB, MB}$
Social Services*	3.35^{NB0}	2.82	2.86	2.55^{LB}
Economic Development*	$3.55^{NB1, NB0}$	3.27	3.09^{LB}	3.09^{LB}

$^{**}p<.01$, $^{*}p<.05$

Tk Tukey HSD post hoc test used on all variables above since equal variances assumed

Table 5: Bridges versus Non-bridges on Collective Efficacy

Weak Ties and Internet Use

Not all bridging leaders and bridging members report that their groups use the Internet (organizational email, listserv, online bulletin board or web site). While most leaders' organizations do use the Net (19 out of 23), four leaders report that at least one of their organizations does not. Nonetheless, three of these four bridging leaders report that they personally use the Internet. Three of the nineteen leaders who report their organizations do use the Internet, report that they themselves do *not.* We know from interview data that two of these three leaders in fact use the Internet *indirectly*, that is, through a friend or colleague (Dunlap, Schafer, Carroll and Reese, in press). Three of the 52 member bridges report they do not use the Internet personally. For two of these three individuals, however, at least two of the groups in which they participate *do* use the Internet for group communication. Therefore, these non-Internet users may get some indirect exposure to online communication, as we can expect the information contained in the Internet messages would be shared among all members.

The effects of using the Internet are different for the subcategories of bridges and non-bridges (Table 6). There are no differences between leader bridges and member bridges on these measures. But leader bridges are different from non-

bridges. Specifically, both leader bridges and member bridges are more connected with local people since going online than non-bridges with one affiliation. Interestingly, non-bridges with one group affiliation report less connectivity with local people since going online than non-bridges with no group affiliations. Both leader bridges and member bridges report more involvement in the local community since going online than non-bridges with no group affiliations. Member bridges report they have been attending more meetings and events of local groups than non-bridges with no group affiliation.

	Leader Bridge (LB) Mean	Member Bridge (MB) Mean	Non-bridge 1 (NB1) Mean	Non-bridge 0 (NB0) Mean
Since online, connected with local people(Tk)**	2.42^{NB1}	2.27^{NB1}	$1.97^{LB, MB}$	2.11
Since online, involvement with local community (Tm)*	2.37^{NB0}	2.20^{NB0}	2.06	$1.96^{LB, MB}$
Since online, attendance at group meetings and events (Tk)*	2.16	2.14^{NB0}	1.94	1.89^{MB}

$^{**}p<.01$, $^{*}p<.05$

Tm Tamhane post hoc test used since equal variances not assumed

Tk Tukey HSD post hoc test used since equal variances assumed

Table 6: Bridges and Non-bridges on Internet Use and Effects

The differences that disappear when we separate out the four groups from the two main categories of bridges and non-bridges are: using the Internet for political activities, and involvement in local issues of interest since going online.

To examine differences among bridges and non-bridges based on Internet use, we used conducted *t* tests on heavy and light Internet users (Table 7). Light users are defined as people who use the Internet 0-1.5 hours per day. Heavy users use the Internet more than 1.5 hours per day. We do not distinguish between bridges that are leaders versus members, just between heavy and light Internet use. Similarly, we do not distinguish between non-bridges who are affiliated with one group and non-bridges with no group affiliations. The *N* (125) is lower than the total sample since this is the subset of Internet users.

Bridge	N=66	Heavy Internet user	N=33
		Light Internet user	N=33
Non-Bridge	N=59	Heavy Internet user	N=30
		Light Internet user	N=29

Table 7: Bridges and Non-bridges by Heavy and Light Internet Use

Analyses using 2 X 2 ANOVAs show that there are significant interaction effects for Internet usage (heavy versus light) and bridges versus non-bridges on several of the study variables (Table 8). These are: social engagement, use of the Internet for social purposes, and attendance at local group meetings and events since going online. These are the only variables that showed significant interaction, and they are all related to social activities.

	Bridge (H) Mean	Bridge (L) Mean	Non-bridge (H) Mean	Non-bridge (L) Mean
Social Engagement †	3.47	3.13	2.96	3.10
Use Internet for Social**	3.55	2.16	2.74	2.17
Since online, attendance at local group meetings and events**	2.27	2.03	1.86	2.00

**$p<.01$, † Approaches significance ($p<.1$)

Table 8: Interactions Between Bridge Status (Bridges or Non-bridges) and Amount of Internet Use (Heavy or Light) on Community Measures

While there were significant main effects for bridge versus non-bridge or for Internet usage (heavy versus light) on many of the variables reported earlier, we do not report them here. The effects for bridge status were shown in previous analyses and the main effects for degree of Internet usage are outside the scope of the present investigation.

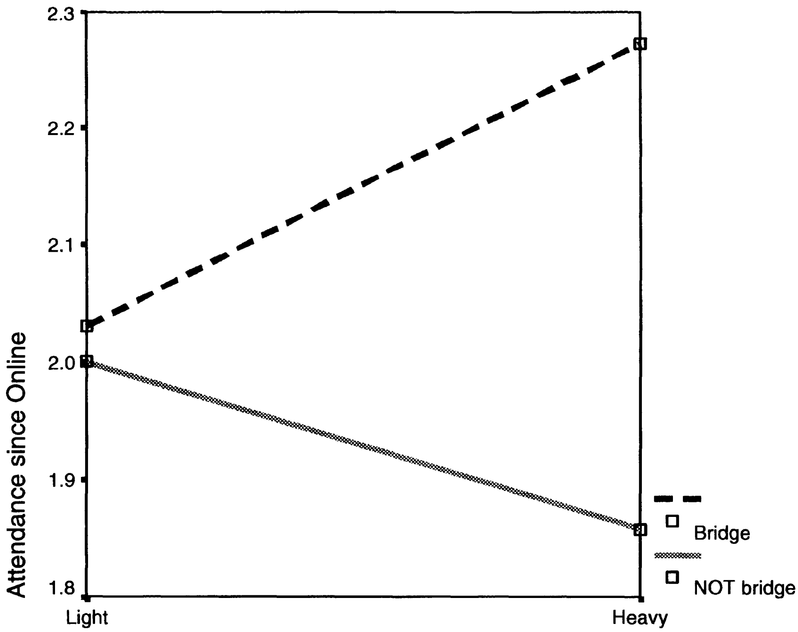

Figure 2: Interaction Between Bridge Status and Internet Usage on Attendance of Local Meetings and Events Since Going Online.

The interaction between bridge status and Internet usage is particularly striking for self-report of attendance at local meetings and events since going online (Figure 2). In this case, both bridges and non-bridges who are light users of the Internet report that their Internet usage has had little effect on attendance. The story diverges for heavy users. While heavy users who are not bridges report that their attendance of local events and meetings has dropped since going online, heavy Internet users who are bridges report that their attendance of local events and meetings has increased.

Discussion

We have examined evidence of weak ties measured by an individual's participation in two or more local groups, either as a leader or member/attendee. We compared these weak ties (bridges) to individuals who participate in only one organization or in no organizations (non-bridges). We tested for differences in their attributes, interests, involvement, collective efficacy and Internet use related to the local community.

The data show that people who act as weak ties (bridges) between groups are better educated, more informed and more extroverted. They have higher levels of activism, trust, community involvement, participation, civic interest, and community attachment. Bridges have greater confidence than non-bridges in the community's ability to work together to solve common problems (measured by collective efficacy and its three dimensions -- active cooperation, social services, and economic development).

We divided the two main categories of bridges and non-bridges into sub-categories (leader bridges versus member bridges, non-bridges with only one group affiliation and non-bridges with no group affiliation). A closer examination of the sub-categories indicates that leader bridges are highest on all measures, and appear to be responsible for much of the differences between bridges and non-bridges. There is a generally declining trend in the level of the means on each attribute and community measure from leaders, to members, to non-bridges with one affiliation and lastly, non-bridges with no affiliation. Leader bridges have higher levels of community participation and civic interest than all other subcategories (both subcategories of non-bridges *and* the subcategory of member bridges). Leader bridges are *not* different from subcategories of non-bridges on measures of household income (where they are different from non-bridges with no group affiliations), and community attachment, and being informed (where they are different from non-bridges with one group affiliation). Member bridges have higher levels of household income than non-bridges with no group affiliation, are more active, and have higher levels of community participation and civic interest than non-bridges in both sub-categories. Leader bridges have greater confidence in the community's ability to work together to solve common problems (measured by collective efficacy and three dimensions -- active cooperation, social services, and economic development) than non-bridges with no group affiliation. Leader bridges are higher than non-bridges with one affiliation on collective efficacy and the economic development component. Member bridges are higher than non-bridges with no group affiliation on collective efficacy and active cooperation. Both leader bridges and member bridges are more connected with local people since going online than non-bridges with one affiliation. Both leader bridges and member bridges report more involvement in the local community since going online than non-bridges with no group affiliations. Member bridges report they have been attending more meetings and events of local groups than non-bridges with no group affiliation.

The differences between sub-categories that disappear when we separate out the four types are: extroversion, trust, sense of belonging, computer interest, political interest, using the Internet for political purposes, and involvement in local issues since online. The significant differences that persist even when we divide bridges and non-bridges into four subcategories are on being informed,

activism, community attachment, participation, collective efficacy and its dimensions, and involvement since going online.

Many of the differences we find between the main categories of bridges and non-bridges are not particularly surprising. We know from previous studies that organizational affiliation, leadership, community involvement and collective efficacy are generally associated with higher socio-economic status.

What this paper has tried to contribute, having presented the evidence for and characteristics of weak ties across groups, is the link to Internet use and effects. In particular, bridges report using the Internet for political purposes (i.e., finding political information, discussing politics online, exchanging email with a government official). Compared to non-bridges, bridges are more involved in the local community, in local issues of interest and more connected with local people since getting on the Internet.

Further, we compared bridges who are heavy Internet users (more than an hour and a half per day), bridges who are light Internet users (less than an hour and a half a day), non-bridges who are heavy users, and non-bridges who are light users. Heavy Internet users with bridging ties have higher social engagement, greater use of the Internet for social purposes, and have been attending more local meetings and events since going online than non-bridges who use the Internet heavily. This finding emphasizes the social nature of Internet use by bridges. It suggests that, in the hands of bridging individuals, the Internet is a tool for maintaining relations and increasing face-to-face interaction, both of which help to build bonding and bridging types of social capital in communities. As noted at the outset, social capital enables members of a community to act collectively to facilitate social and economic development and solve common problems. When we consider community collective efficacy as a measure of the potential for collective action, higher collective efficacy among bridges suggests they are predisposed to facilitate such activity, as necessary. As Bandura (2002) noted, if people believe that they can achieve desired results by using communication technologies, they will use those tools to help make their voices heard and play an active part in meaningful change. The findings presented here suggest that bridges act on their higher sense of collective efficacy to educate and organize and to facilitate change by all means possible, including the Internet.

In future research we will investigate how leader and/or member bridges compare with the concept of local versus cosmopolitan influential community residents (Merton, 1968). We would expect leader bridges to have traits of both, but for their Internet use to vary according to their local versus cosmopolitan orientation. That is, cosmopolitan influentials would not only keep up with local news, they would also follow closely national and global events, politics and social concerns. An investigation of email use might show similar patterns whereby online communication by local influentials is predominantly with local social circles and organizations. Local influentials are likely to have stronger

attachment to the community than cosmopolitans who are more willing to move out of the area. Nonetheless, cosmopolitans are associated in diffusion theory and research with early adoption and spread of innovation (such as computer networking). The combination of both cosmopolitans and locals – which we have in the university town of Blacksburg and the surrounding rural farming area of Montgomery County – may be the ideal combination for innovation and participation.

We will also examine Putnam's differentiation between the community roles of *machers* versus *schmoozers* in future research. *Machers* is a Yiddish term for people who spend a lot of time in formal organizations and work to bring about change. This comes closest to our construct of 'Activism.' *Machers* are the classis good citizens: they keep up with current events, attend church and club meetings, volunteer, give to charity, work on community projects, read the newspaper, give speeches, follow politics, and attend local meetings (p. 93). *Schmoozers* are more involved in the social side of community life. Their engagement is less formal and goal-oriented than *machers,* more like our constructs of 'Social Engagement' and 'Belonging'. *Schmoozers'* socializing is with friends and family, rather than with influential people and organizations in the community. According to Putnam, distinctions between *machers* (formal community) and *schmoozers* (informal social engagment) reflect differences in social standing, life cycle, and community attachment. *Machers* tend to be better educated and to have higher incomes, whereas informal social involvement is common at all levels in the social hierarchy.

Finally, future research should include a re-examination of Brieger's (1974) conception of the duality of persons and groups. Breiger draws on Simmels' notion of duality to define the value of a tie between any two groups as the number persons who belong to both groups. Clearly, a weak tie would be one where two groups were linked through only one person. His membership network analysis may prove very fruitful in examining weak ties versus strong ties across community groups and differences in effects of communication and information sharing .

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A Bayesian Computational Model of Social Capital in Virtual Communities

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Abstract. The theory of social capital (SC) is frequently discussed in the social sciences and the humanities. There is a plethora of research studies, which seek to define and empirically test the idea of SC in a number of ways. This growing body of research has only supported the significance of (SC) in physical communities. While many attempts have been made to examine different forms of social capital in physical communities, its application to other types of communities remains open to research. Recent interest in computer science and information systems in studying virtual communities (VCs) and the value these communities provide to information exchange and knowledge construction makes examination of SC in these communities relevant. We begin our understanding of SC in VCs by mapping out different variables that constitute SC based on qualitative experts' knowledge of SC. We then develop an initial computational model of SC, and generate conditional probability tables (CPTs) that can be refined using real world case scenarios developed by experts in virtual communities. The Bayesian model seems to represent the situations mentioned in the paper adequately. This model provides a useful tool for understanding of SC in VCs.

Introduction

Recently a substantial body of research has sought to define, test and apply the theory of social capital (SC) in physical communities. Studies show that building social capital requires continuous positive interaction that enables people to identify common goals, achieve shared understanding and norms, build trust, and commit themselves to each other (Prusak & Cohen 2001; Putnam, 2000; World

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Bank, 1999). Lesser (2002) has pointed out that positive interactions, which occur between individuals who form networks, can lead into the formation of SC.

Further, SC can also be developed and fostered when individuals believe that their actions will be appropriately reciprocated, and that each member of a community will meet expected obligations and abide by available social norms. Thus, issues around trust, shared norms and values, obligations and expectations are critical in developing social capital among members of a group (Nahapiet & Ghoshal, 1998; Putnam, 2000; Prusak & Cohen 2001).

Research mainly in social science and the humanities has repeatedly examined the notion of SC in physical communities. For example, SC is used to address the problems of lack of civic engagement (Putnam, 1993; 2000), the role of SC and civic virtue (Sirianni & Friedland, 1995); SC in community and school achievement (World Bank, 1999); SC in development (Gittell & Vidal, 1998); SC and organizational development (Prusak & Cohen, 2001) and SC as a means of addressing the issue of the "digital-divide and digital-dividend" (i.e. the social disparity gap created by lack of technological skills in society and the benefits to those who possess such skills) (Resnick, 2002).

Despite this plethora of research seeking to examine and understand the nature and value of SC in physical communities, little has been done to extend this understanding to other forms of communities. This paper contributes by extending the understanding of SC to virtual communities (VCs). This understanding also serves as basis for constructing and testing a computational model of SC. We argue that modelling SC enables systems' designers to build tools and systems that support the analysis, formation, and sustainability of SC in VCs. We use Bayesian Belief Networks (BBNs) (Pearl 1988) to create a model of SC. This model is constructed out of qualitative descriptions of the degree of influence between any two related variables. Moreover, the variables that constitute to SC are driven from experts' knowledge of SC and VCs. We have run a series of experiments to validate the initial model. The results of the experiments also help us to determine the most essential variables within SC.

The rest of the paper is organized as follows. We first examine the meaning and nature of SC. Second, we review related work on SC in physical communities. This leads us to a discussion on the relevance of the concept in VCs. Third, we describe the approach and methods we used in constructing the Bayesian model and its conditional probability tables (CPTs). Fourth, we present our experiments and the results. Finally, conclusions are drawn and future work is presented.

The Nature of Social Capital

The notion of SC is different from other forms of capital such as human capital, financial capital and physical capital. Unlike these other forms of capital, SC is a

stock of active connections among people, which covers the trust, mutual understanding, and shared values and behaviours that bind people as members of human networks and communities (Cohen & Prusak, 2001). This stock of capital like human capital cannot be easily translated into dollar value. This difficulty is one of the reasons why SC is not commonly embraced and valued especially in business. A fundamental difference between SC and the other forms of capital is quality rather than quantity. Simply put, SC reveals the presence or absence of a set of relationships among people. These relationships can be productive when they are based on a common set of expectations, a set of shared values, and a sense of trust among people. The quality of this set of relationships enables people to work together and accomplish common goals.

It is also possible to notice the lack of SC in a community, through the determination of the absence of productive relationships, a lack of shared understanding, presence of distrust, which, normally results in conflicting values and goals. For example a community that has difficulties collaborating or working together exhibits a lack of SC.

Related Work

SC resides in individuals and within a community. It enables individuals to collaborate, work, and learn as a community. This resource is usually available to any member in a particular community; it can also be an individual's private good. For instance a community with individuals that are well connected to each other manifest a high public or common SC, while a single individual who is well connected to other individuals in a community might own a high private SC compared to others who are loosely connected.

The value of SC in physical communities is well founded. Previous research shows that SC allows people to resolve collective problems more easily (World Bank, 1999). That is people are normally well off if they cooperate with each other. But in a case where individuals benefit more by shirking their responsibility, hoping others will do the work for them, normally there are mechanisms—social sanctions for coping with such a breach in social norms.

Putnam (2000) has observed that SC greases the wheel that allows communities to advance smoothly. Prusak & Cohen (2001) have also suggested that when people trust each other and preserve continuous interaction, they sustain social capital. In this case, presence of trust makes every day business easy and fun. Without trust however, conducting business will become complex and difficult.

A network that constitute SC also serve as a conduit for helpful information dissipation that will contribute to achievement of personal as well as community goals. For instance, people who are well connected usually get good news first. In addition, SC can also help to preserve social norms in a community and reduce

delinquent or egoistic behaviour. It is common to notice that people who are well connected in a community and have active trusting connections with others are likely to behave within the prescribed social order of their community. To illustrate this point, take for example any religious leader who will normally be constrained to behave in specific ways because of the expectation the community puts on them. This can be the case with other respected professions in communities, including teachers, professors, doctors, police, lawyers etc.

The benefits of SC have been extended to educational realms. Researchers at the World Bank (1999) use a number of statistics to support the case for SC in education. They argue that schools are more effective when parents and local communities are actively involved. Teachers are more committed and students have high-test scores. Also parents better utilize school facilities in communities with a high stock of SC and citizens take active interests in children's educational achievement (Coleman and Hoffer 1987; Braatz and Putnam, 1996; Francis et al 1998).

Further, the World Bank researchers argue that poverty in some countries can be caused by lack of connections to the formal economy including material and informational resources, the poor people have limited SC, and the little they have is primarily derived from family and neighbours. Therefore, increases in SC of the poor help them to transcend their closed networks in order to access additional resources.

We further argue that in any multicultural settings with little shared understanding, SC can help break down traditionally deeply held belief systems and hence can increase shared understanding within a group. For instance, imagine an *agent x* who stereotypically believes that *agent q* is lazy because *agent q* belongs to a family of *agents z,* and all members of the *agent z* family have a history of being lazy. Suppose *agent x* has a trustworthy friend, *agent p*, who has interacted with agent q from the *agent z* family, and *agent p* suggests to *agent x* that some members of the *agent z* family are not necessarily lazy. *Agent x* is likely to change his/her degree of belief in the laziness of all *agents* in the *agent z* family thus increasing shared understanding between *agent x*, and the *agent z* family. Though another possibility might be *agent x* starts to distrust agent p, depending on how seriously he/she believes in *agent z*'s degree of laziness.

In collaborative learning environments, SC can act as a pipeline for exchange and sharing of "tacit knowledge" (non-formal knowledge that is accumulated through personal experiences). As Prusak & Cohen (2001) have pointed out, SC can promote better knowledge sharing, when trusting relationships are established. For instance, individuals can easily share experiences and knowledge when they connect with other individuals in a community. In addition, individuals who are well connected to other individuals in a community are the ones that are likely to obtain and benefit from peer support. By the same token those who are

well connected in a community are the ones who are likely to offer peer support when necessary because they might carry sense of obligations to their community.

Despite a wide range of research evidence in support of the value of SC in physical communities, there is a lack of research that examines the notion of SC in VCs. Our goal is to extend this understanding of SC to VCs. Most proponents of SC argue that SC in physical communities produces trust (Putnam, 2000; World Bank, 1999). However, in virtual communities, where most individuals barely know each other, it is difficult to establish and develop trusting relationship. This implies that the development of SC, in most cases which is dependent on trust in virtual communities is influenced by a number of variables such as individuals being aware of each other backgrounds and the goals of the community, the nature of interaction, attitudes of individuals interacting etc.

Creating computational models out of such variables has been a daunting and imprecise activity. Bayesian Belief Networks (BBNs) (Pearl 1988) have become accepted and used widely to model uncertain reasoning situations and cause–effect and other probabilistic relationships. BBNs have been used in such areas as: diagnosis of medical problems, diagnosis of malfunctioning systems, planning in uncertain domains, speech recognition, user modelling and story understanding. The causal information encoded in BBNs facilitates the analysis of action sequences, observations, consequences, and expected utility. Related variables are connected in a DAG (Directed Acyclic Graph). Conditional probabilities are attached to each variable (node) based on its direct dependencies. Using BBNs it is possible to integrate new evidence and propagate it through the model.

Although BBNs originated in the AI/CS community as an effective computational tool for manipulating joint distributions of many variables, BBNs are beginning to be seen by some philosophers and social scientists (e.g. Cartwright) as providing a complete treatment of path analysis (Sewell Wright), which has significant application in the social sciences.

Social Capital in Virtual Communities

Our discussion of SC in VCs begins with basic understanding of the concept of community and carries on to distinguish major forms of VCs. A community is a group of people who socially relate to each other to achieve some common interests or goals. These relationships often reinforce one another (rather than being one-on-one). Fundamental to this notion of community is a measure of commitment to a set of shared values, norms, and meanings, and a shared history, and identification within a particular culture.

A physical community resides in one fixed locale and its members usually often meet, talk and know each other pretty well. While a virtual community is a composite of people, the space where they interact, their goals, and the

technologies that they use to communicate, collaborate, and work together to achieve their goals as a community.

There are varied forms of virtual communities, most of which are organized around temporal community models and may share certain elements in common. In this paper we distinguish two major forms of virtual communities a virtual learning community (VLC) (McCalla, 2000; Schwier, 2001), and a virtual community of practice (VCoP) (Wenger & Lave, 1991). Though similar to the notion of CoPs, our notion of VCoPs conducts most of its activities in cyberspace.

A virtual learning community is a group of people who gather in cyberspace with key intention of pursuing learning goals (Daniel, McCalla & Schwier, 2002). While all virtual communities have an element of learning in them not every community can be called a learning community. A learning community is so called when all its members have explicit goals involving learning. A virtual learning community taken as whole is greater than the sum of its parts, that is, highly skilled or knowledgeable individuals in a community is a necessary, but often not a sufficient condition for a community to be termed as "learning community." Such individuals should join those who are less knowledgeable so that they all learn together continuously as a community.

In the corporate sector, communities are mainly organized around specific work related activities normally referred to as communities of practice (CoP). Wenger & Snyder (2000) define CoP as a group of people who are informally bound together by shared expertise and passion for a joint enterprise. Such a group is also characterized by tight-knit individuals working towards common goals and who are willing to collaborate to solve common problems, share best practices, support each other, and have a common identity.

In an ideal world, virtual communities hold enormous potential for development of SC. In fact, the spectacular rise of electronic mail, Internet services, and telecommunications offers unprecedented opportunities to access instant information and connect with individuals either within the same community or in other communities.

Paradoxically, instant access to information also implies information overload and hence a growing need to deal with the overload. There are a number of strategies individuals can deal with information overload. McCalla (2000) for instance has noted that when individuals are faced with information overload in cyberspace, they drastically constraint their interaction, forming "electronic villages". This suggests that individuals make connections with other individuals in other "electronic villages", forming a bonded type of SC in the terms of Putnam (2000). Bonding SC can help individuals manage and determine what information is relevant to communicate and how to present this information in useful ways to other individuals in their own "electronic villages".

In the corporate sector, using information and communication technologies that support the infrastructure of virtual communities, various companies can now

make connections and establish relationships with customers, suppliers, and other contractors fairly quickly. In fact, companies that can easily develop SC with their consumers are likely to succeed in turbulent competitive markets. For instance, they can acquire instant feedback to improve their products from current consumers and while new consumers can quickly review other consumers' feedback to make decision. Today, companies like Amazon and eBay apply similar strategies to develop and maintain relationships with their customers.

SC can also foster competition among companies, and hence, companies can constantly strive to produce better products and services in order for them to stay on top of their competitors. In fact, companies that have high SC, with their competitors (bridging--social capital) have access to relevant information about their competitors and are likely to understand the quality of products and services produced and provided by their competitors. Such an understanding enables them to produce high quality products and services.

Though there are numerous possible benefits of SC in VCs, the concept is still ill defined. We based our definition of SC the definition provided by Prusak & Cohen (2001). We assume that SC in VCs is the outcome of trusting relationships, and that a number of variables affect SC through trust. This definition of SC is the basis of our model of SC.

Social Capital and Bayesian Beliefs Networks

BBNs are useful for representing imprecise, incomplete and uncertain knowledge. However, knowledge engineering effort required to create conditional probability tables per each of the variables given its parents in the model has prevented many researchers to use them in different areas. Although, there are algorithms to learn prior and conditional probabilities from data, this is not always possible which makes it necessary to elicit these probabilities from experts. In order to overcome this issue qualitative description of conditional probabilities has been proposed. Related research in this area includes qualitative probability networks proposed by Wellman (1990) and extended by other authors such as Druzdzel and Henrion (1993).

Although in qualitative probability networks degrees of influence between each pair of variables in the network are assigned, they do not map these degrees of influence to actual CPTs. Instead, qualitative probability networks implement their own algorithms to propagate evidence using just the degrees of influence (i.e. positive or negative, strong, medium and weak). The approach presented later in the next section maps qualitative degrees of influence to CPTs so that any of all the existing algorithms for BBNs can be used. Lacave & Diez (2002) used a similar approach. This approach generates an initial network that could be further refined by using systems such as cbCPT (Zapata-Rivera 2002). In fact, the model of SC presented in this work has been refined in different ways.

SC is an imprecise concept, and it is also a multidimensional concept, incorporating different levels and units of analysis. Trust, civic engagement, and community involvement are generally seen as ways to measure social capital (Putnam, 1993; Putnam, 2000; Prusak & Cohen, 2001). Since SC is multivariate concept, some variables may be more significant than others. We use BBNs to model the interactions among the variables constituting SC. In the next section we present procedures and methods for the construction of an initial computational model of SC.

Methods and Procedures

In this study we have undertaken a naturalistic qualitative research method. In particular, we have used participant observation, which involve immersion and observation of various activities in the communities studied. We have also used unstructured interview technique to gather further data on the experiences of other participants of different virtual communities. As Hammersley & Atkinson (1983) noted that a participant observation approach requires an observer to become some kind of a member of the observed group, and establish a role within the group. More over an observer needs to maintain a critical role in the group being observed. And hence, should establish physical presence and familiarity with the social protocols of the group or community (habits, use of language, non-verbal communication). The interpretation of the data driven through this approach was transcribed by explaining the meaning of experiences of particular individuals observed through experiences of the observer.

More specifically, in order to gain deep understanding of the nature of interaction and social relationships that constitute SC in VCs, we first interviewed two experts about the nature of SC, and what are the critical variables, which constitute SC. The experts interviewed included one researcher in the area of SC in temporal communities and one other expert in both SC and VCs. We asked experts to define main variables constituting SC and to describe critical relationships among the variables. Second, one of the researchers participated and was actively involved in various learning activities of more than three virtual communities for a period of at least three years. His involvement further enables him to observe and acquire various experiences in virtual communities. An unstructured interview was also administered on fifteen participants of three different VCs. Participants were asked to describe their experiences on interaction and social relationships in VCs. We also draw secondary data based on the results of a case study of eight participants in a virtual learning community (Dykes, 2003). The main goal of the study was to explore students learning experiences in virtual learning communities.

In collaboration with the experts, an initial Bayesian structure for SC showing relationships among variables using different degrees of influence was created

(see Figure 1.). Further from the results of the participants' interviews, several case scenarios were extracted and used to test the behaviour of the model created by the experts and the researchers.

Variables in the model include type of community, attitudes, interactions, shared understanding, demographic cultural awareness, professional cultural awareness, task knowledge awareness, individual capability awareness, knowledge about norms, trust, and social capital. We represent various degrees of influence by the letters S (strong), M (medium), and W (weak). And the signs + and - represent positive and negative relationships. The experts and the researchers then collaboratively work together to test the Bayesian model using different pieces of evidence from the case scenarios.

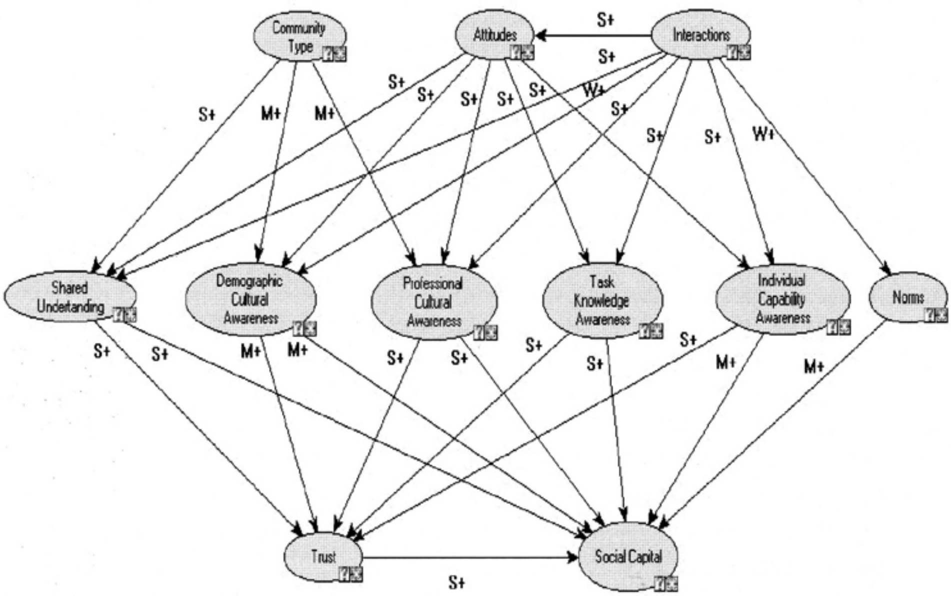

Figure 1: A Bayesian Model of Social Capital in Virtual Communities

We explain how conditional probabilities are obtained from qualitative descriptions of the influence between variables using a simple example. The Bayesian model shows that *Attitudes* (a binary variable, states: positive and negative) and *Interactions* (a binary variable, states: positive and negative) influence in a positive strong manner *TaskKnowledgeAwareness* (a binary variable, states: high and low). Depending on the kind of evidence coming from a

parent (i.e. the observed parent's state) and how it affects the child, positive and negative relationships are defined. In our case, for example, a positive relationship between *Attitudes* and *TaskKnowledgeAwareness* means that in the presence of evidence of positive *Attitudes* in the community, the probability of high levels of *TaskKnowledgeAwareness* will increase. Similarly, evidence of negative *Attitudes* will increase the probability of low levels of *TaskKnowledgeAwareness*. On the other hand, a negative relationship between *Attitudes* and *TaskKnowledgeAwareness* means that there is an inverse relationship between the variables.

In order to create conditional probabilities out of qualitative descriptions of the strength of the relationship, our approach adds weights based on the number of parents and the kind and the strength of the relationship. Following with our example and assuming positive relationships, we determine the weights associated to each degree of influence. First, a threshold value is associated with each degree of influence. These threshold values correspond to the highest probability value that a child could reach under certain degree of influence of its parents (i.e. assuming that *Attitudes* and *Interactions* have positive strong relationships with *TaskKnowledgeAwareness*, evidence of positive interactions and positive attitudes will produce a conditional probability value of 0.98 of *TaskKnowledgeAwareness* = high). The corresponding weights are obtained by subtracting a base value (1 / number of parents, 0.5 in our case with two parents) from the threshold value associated to the degree of influence (i.e. threshold value for strong = 0.98) and dividing the result by the number of parents (i.e. (0.98 - 0.5) / 2 = 0.48 / 2 = 0.24). Table 1 presents threshold values and weights used in our example. The value α = 0.02 leaves some room for uncertainty when considering evidence coming from positive strong relationships.

Degree of influence	**Thresholds**	**Weights**
Strong	$1-\alpha = 1 - 0.02 = 0.98$	(0.98-0.5) / 2 = 0.48 / 2 = 0.24
Medium	0.8	(0.8-0.5) / 2 =0.3 / 2 = 0.15
Weak	0.6	(0.6-0.5) / 2 =0.1 / 2 = 0.05

Table 1: Threshold values and weights with two parents

In our case, let's assume that Attitudes and Interactions have positive strong relationships with *TaskKnowledgeAwareness* and there is evidence of positive *Attitudes* and *Interactions* in a particular community. That is, weights will be added to the conditional probability table of *TaskKnowledgeAwareness* every time *Attitudes* = positive or *Interactions* = positive. For example, the conditional probability value associated with *TaskKnowledgeAwareness* given that there is evidence of *Attitudes* = positive and *Interactions* = positive is 0.98. This value is

obtained by adding to the base value the weights associated to *Attitudes* and *Interactions* (0.24 each). Table 2 shows a complete conditional probability table for this example.

	Attitudes	**Positive**		**Negative**	
	Interactions	**Positive**	**Negative**	**Positive**	**Negative**
TaskKnowledge Awareness	**High**	0.98	0.74	0.74	0.5
	Low	0.02	0.26	0.26	0.5

Table 2: CPT for two parents with positive strong relationships

P(*TaskKnowledgeAwareness*= high | *Attitudes*= positive & *Interactions*= positive) = 0.5 + 0.24 + 0.24 = 0.98

P(*TaskKnowledgeAwareness*= low| *Attitudes*= positive & *Interactions*= positive) = 1 - 0.98 = 0.02

P(*TaskKnowledgeAwareness*= high| *Attitudes*= positive & *Interactions*= negative) = 0.5 + 0.24 = 0.74

P(*TaskKnowledgeAwareness*= low | *Attitudes*=positive & *Interactions*= negative) = 1 - 0.74 = 0.26

P(*TaskKnowledgeAwareness*= high | *Attitudes*= negative & *Interactions*= positive) = 0.5 + 0.24 = 0.74

P(*TaskKnowledgeAwareness*= low | *Attitudes*= negative & *Interactions*= positive) = 1 - 0.74 =0.26

P(*TaskKnowledgeAwareness*= high | *Attitudes*= negative & *Interactions*= negative) = 0.5 **

P(*TaskKnowledgeAwareness*= low |*Attitudes*= negative & *Interactions*= negative)=1-0.5=0.5

Since the expert has not provided any information about what to do when there is evidence of *Attitudes* = negative and *Interactions* = negative, no value has been added to the base value (0.5 **). However, one expects to get a high conditional probability value of *TaskKnowledgeAwareness* = negative when *Attitudes* = negative and *Interactions* = negative, a possible alternative would be to use P(*TaskKnowledgeAwareness* = positive | *Attitudes* = negative & *Interactions* = negative) = 0.02 and P(*TaskKnowledgeAwareness* = negative | *Attitudes* = negative & *Interactions* = negative) = 0.98 assuming that a positive strong relationship also occurs when *Attitudes* = negative and *Interactions* = negative. Table 3 shows this conditional probability table.

	Attitudes	*Positive*		*Negative*	
	Interactions	*Positive*	*Negative*	*Positive*	*Negative*
TaskKnowledge Awareness	*High*	0.98	0.74	0.74	0.02
	Low	0.02	0.26	0.26	0.98

Table 3: Alternative CPT for two parents with positive strong relationships

Using this approach it is possible to generate conditional probability tables (CPTs) for nodes with any number of parents and different degrees of influence assuming that the expert defines degrees of influence using one kind of evidence (i.e. evidence coming from one of the parent's states). However, when the expert defines degrees of influence for more than one of the parents' states, adding weights could result in ties, which could generate inconsistent CPTs. In such cases, one could ask the expert which parent should be used in case of ties (i.e. which variable prevails). This extra parameter can be used to solve conflicting situations.

Using this approach we have generated CPTs for all the variables in the Bayesian model of SC. It is important to mention that without this approach eliciting conditional probabilities for most of the variables especially for *Trust* (5 parents) and *Social Capital* (7 parents) would have been a difficult task. Next sections present some of the scenarios used to refine and test this initial Bayesian model of SC.

Descriptions of Case Scenarios

In this section we describe three different communities that will be used to test and to refine the initial Bayesian model of SC. Cases were randomly selected from two main types of virtual communities: virtual learning communities (VLCs) and communities of practice (CoPs).

Community A

Community A is a virtual learning community of graduate students learning fundamental concepts and philosophies of educational technology for a period of six months, from September 2001 through April 2002 at the University of Saskatchewan, Canada. They come from diverse professional training and cultural backgrounds. Participants come from Africa, Asia and North America most of them are practising teachers teaching in different domains at secondary and primary schools levels.

The researchers observed that though some individuals in the community have extensive experiences with educational technologies, they are not exposed to each other and thus are not aware of each other's talents and experiences.

This community has a strict formalised structure and all the individuals know explicit goals. There is a common goal to all individuals, that is successfully completing the class but also individuals might have different individual goals when it comes to how much they are willing to learn about the domain. We observed positive interaction in this community, but as the interactions progressed, flaming attitudes were observed. Individuals began to disagree more on the issues under discussion either because they disagreed with their colleagues' opinions, or they did not understand the issues.

Community B

Community B is what can be referred to as "a community of practice" for software engineers who gather in cyberspace to discuss issues around software development. Their general goals were sharing information, and providing knowledge and peer-support. Members in this community share common concerns and are drawn from all over the world. They can be categorized into two groups; highly experienced software developers and novices.

Despite diversity in demographic culture, community members are aware that all members come from the same professional practice (culture) and share the same goals. This was evident because of the nature of interaction, i.e. use of the same frame of reference, questions asked etc. At first, the community does not know individual's diversity in skills and demographic culture. But after a considerable period of interaction, individuals were exposed to each other and began connecting and exchanging personal information. It was also observed that some individuals who seemed to be more vocal offered a lot of help and became well known in the community. There was reasonable level of shared understanding but formal social norms for interaction were not stated. Activities in this community were informally organized.

Community C

This community consists of a group of individuals learning fundamentals of programming in Java. It is an open community whose members are geographical distributed and they have diverse demographic and professional culture but are not aware of each other's backgrounds. The researchers were able to infer as the individuals interacted, that individuals had diverse programming experiences, skills and knowledge. Participants range from novice to experienced students and from corporate experts to amateurs. It was interesting to observe that though these individuals at first did not know each other, they were willing to offer help and to support each other in learning Java.

Though there were no formal norms of interaction, individuals interacted as if they were some kinds of set down rules. This community had no defined goals, but rather individuals are mainly concerned about asking or answering questions.

Experimental Design

In order to test our initial Bayesian model of SC, each case scenario is analysed looking for evidence regarding the variables in the model. Once evidence is added to the model (i.e. observing a particular state of a variable), it is propagated to the rest of variables following the structure of the Bayesian model. This process generates a set of new marginal probabilities for the variables in the model. We are especially interested in analysing the levels of trust and SC on each of the communities. In addition, it is possible to make inferences based on the probabilities generated on any of the variables (nodes) of the model.

Results

These results are based on the nature of the cases described. It should be noted the cases themselves represent general characteristics of a community given specific types of observed interactions. It might be possible to come up with more cases and variables to replicate the experiment. In the next section, we describe the results from each of the case scenarios.

Community A

Community A is a virtual learning community (Community Type = *VLC*.) Based on the case description shared understanding is set to *low* and professional knowledge awareness is set to *doesnotexist*. Individuals in this community are familiar with their geographical diversity and so demographic cultural awareness is set to *exists*. There is well established formal set of norms set affront by the teacher (Norms = *known*.) Figure 2 shows the Bayesian model after the evidence from community A has been added (shaded nodes) and propagated through the model.

Propagating the evidence resulted into a low level of trust (P (Trust=*low*)=0.633) and a corresponding *low* probability level of SC (P (SC=*low*)=0.593). Several explanations can be provided for the drop in the levels of SC and trust. Based on the model the probabilities of interactions and attitudes being negative are *high*. This can be explained by the lack of shared understanding in the community and the lack of professional cultural awareness.

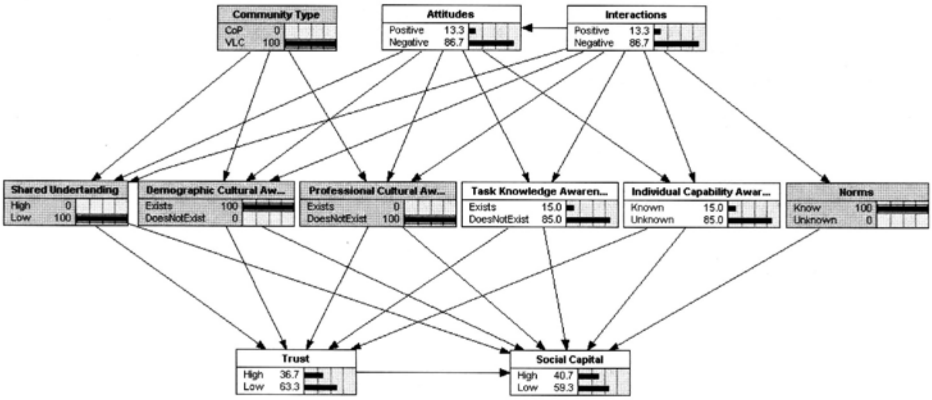

Figure 2: A Bayesian model of SC when evidence from community A has been added and propagated through the model

Drawing from the model it can be observed that the probability of task knowledge awareness being *doesnotexist* is high (0.85) and individual capability awareness is *unknown* (0.85). It be can inferred that lack of shared understanding and professional cultural awareness have further affected the levels of task knowledge awareness and individual capability awareness through negative interactions and attitudes. For instance, opinions of those individuals in the community that are more knowledgeable can be ignored, which makes them to pursue more of their personal goals other than cooperating towards the achievement of community goals. Finally, we can conclude that the drop in the levels of trust and SC are attributed to the lack of awareness and the presence of negative interaction and attitudes in this community.

Community B

Variables observed in this case include community type which has been set to community of practice (*CoP*), professional awareness culture was set to *exists*, since after interaction, we were able to determine that individuals in that community became aware of their individuals talents and skills, individual's capability awareness and task awareness were set to *exists* as well. Individuals in this community share common concerns and frame of reference, and so shared understanding has been set to *high*. Figure 3 shows the Bayesian model after the evidence from community B has been added (shaded nodes) and propagated through the model.

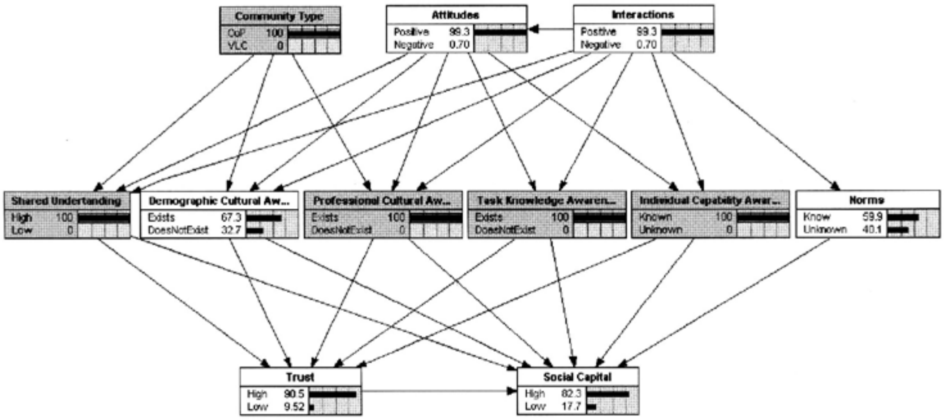

Figure 3: A Bayesian model of SC when evidence from community B has been added and propagated through the model

Propagating this set of evidence, we observe high levels of trust and SC (P(Trust=*high*)=0.905 and P(SC=*high*)=0.823) . Given the evidence, we observed that the interactions and attitudes in the model are positive which, influences in a positive way demographic cultural awareness and norms.

Further, the presence of shared understanding and the high degrees of different kinds of awareness and knowledge of norms in this community have resulted into significantly high levels of trust and SC. Based on this scenario we can see that demographic cultural awareness has little influence on the level of trust in communities of practice. Subsequently, it does not affect SC much. This simply relates to the fact that professional culture is more valued than demographic culture in CoPs. For instance, people in CoPs mainly build and maintain social relations based on common concerns other than geographical distribution. This indicates that geographical distribution matters less in this case.

Community C

Variables extracted from this case scenario include, community type (*VLC*), shared understanding *unknown,* and professional cultural awareness, demographic cultural awareness, individual's capability awareness and task awareness were set to *exists*. Figure 4 shows the Bayesian model after the evidence from community C has been added (shaded nodes) and propagated through the model.

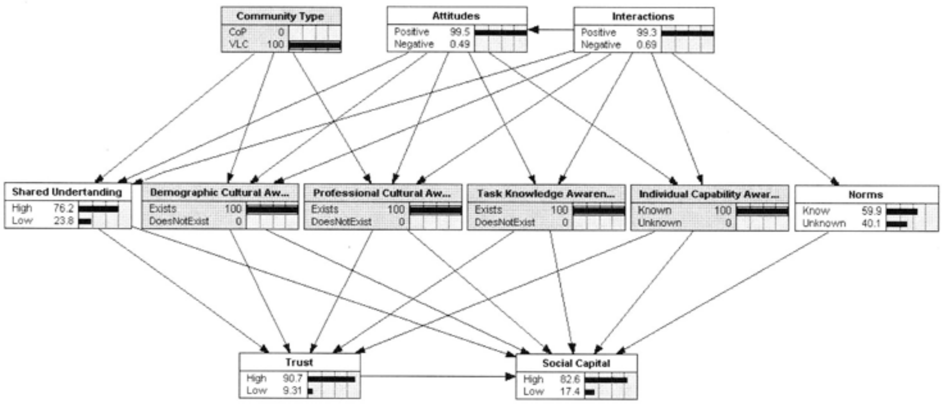

Figure 4: A Bayesian model of SC when evidence from community C has been added and propagated through the model

In community c, we observe high levels of trust and SC (P (Trust=*high*)=0.907 and P (SC=*high*)=0.826). These high levels of trust and SC can be explained by the fact that the community is focused on a particular domain. This issue can be observed in the model by looking at the high levels of shared understanding and different forms of awareness. Finally, the model indicates it is more likely that interactions and attitudes are positive in this community given the observed evidence.

Conclusion and Future Work

The theory of SC is well researched in physical communities. Though there are many benefits associated with SC in physical communities, no attempt has been made to examine this stock of social capital in VCs. The results of our experiments show that SC is a multifaceted concept, formed out of different variables. We have also shown that trust, shared understanding and different forms of awareness have significant influence on the levels of SC in VCs. Furthermore, different variables that are positively related to trust affect SC directly. These variables in turn behave differently at different levels, depending on the type of community. In addition, we have inferred that VLCs that are organized within a specific domain manifest high levels of trust and SC given the presence of shared understanding and different forms of awareness.

The Bayesian model described in this paper seems to represent the situations mentioned in the case scenarios adequately. However, this model or variations of it could be used to represent similar cases. It is further possible that this particular Bayesian model can be updated to adapt to different situations. It could be the case that several Bayesian models involving different variables and/or

relationships among the nodes are needed for different kinds or groups of scenarios.

This paper offers three major contributions. First we extend the notion of SC to VCs. Second, we have developed an initial computational model of SC that can be tested and refined using real world case scenarios of VCs developed by experts. Third, we have developed and shown that it is possible to use a computational approach and to create CPTs out of a qualitative description of the strengths between variables. This can then be used to model imprecise and incomplete knowledge in a variety of domains in the social sciences and the humanities.

Though the results of this study are limited to the scenarios described, different scenarios can be developed and tested against the model, it is possible to replicate the experiments and refine the model. Our future work, however, will involve development of more formal measures of each of the variables in the model, and investigation of how to improve the levels of SC and trust using different strategies. We will also continue working closely with experts in VCs to develop more case scenarios and collect more data on various VCs and use this data to validate the model. Once a Bayesian model of SC, which can satisfactorily represents a group of virtual communities has been achieved, it could be updated dynamically as time and interaction in a community progresses. We will also explore more communities with more participants and identify and build tools, which support the creation and sustainability of SC in VCs.

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I-DIAG: From Community Discussion to Knowledge Distillation

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Abstract. I-DIAG is an attempt to understand how to take the collective discussions of a large group of people and distill the messages and documents into more succinct, durable knowledge. I-DIAG is a distributed environment that includes two separate applications, CyberForum and Consolidate. The goals of the project, the architecture of I-DIAG, and the two applications are described. We focus on technical mechanisms to augment social maintenance and social regulation in the system.

Introduction

Imagine the following scenario: The president of a large public university in the US asks a blue-ribbon panel of his highly regarded faculty to reflect upon the future of their university. The president wants to keep their university not only in the forefront of similar universities but also in front of basic societal pressures and opportunities. However, the faculty are also admonished to consider the various often-overlooked stakeholders – the university's staff, undergraduate students, graduate students, alumni, non-tenured instructors, state legislature members, and local community residents. A large US state university may have several thousand faculty members, and the various concerned stakeholders might include 50 thousand or more people. Of course, the faculty committee could do as a typical

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blue-ribbon panel often does, going into their respective rooms to inscribe their already acquired expertise. But if they wished, how might they reach out to these stakeholders, include their perhaps divergent opinions, and search for new and interesting opinions and options?

We know that Internet-scale systems can provide forums for large groups (> 10^5 people) to gather, discuss, and trade ideas. Within a corporate setting, these systems can be used for brainstorming, new produce ideas, quality circles, and the like. Governments, institutions, and universities can discuss such issues as organizational change and future plans in order to come to a "shared mind".

Yet all too often problems arise in these attempts. People do not come to the site, or do not stay on topic. More importantly, once use has finished (either by deadline or by neglect), the site is often a bramble of ideas and topics, too large and unwieldy for its information to be successfully reused.

Our system, I-DIAG[1], investigates how to garner and then distill this valuable community knowledge. It is part of a larger project to investigate how to maintain and reuse informal information within organizational and Internet-scale settings.

The paper is arranged as follows: We begin with a description of the research problems under consideration, and follow that with a brief overview of the relevant literatures. We then discuss the architecture of I-DIAG as well as provide a description of the various components of I-DIAG. (I-DIAG consists of a number of applications and distributed services.) This is followed by a discussion of three facilities to augment important social aspects of I-DIAG's use – social maintenance, social facilitation, and social regulation. We conclude with future work and directions.

Research Overview

We created I-DIAG to consider several general research problems as well as provide a concrete application with which to examine these problems. Overall, we are investigating:

- New models for refinement and distillation. Our primary interest is in finding social and technical mechanisms to facilitate the distillation of knowledge from large amounts of informal information, such as bulletin-board messages, chat messages, e-mail, or quickly written brief documents. Our argument below is that previous mechanisms have failed because of the

[1] The main quad of the University of Michigan campus is called the Diag. I-DIAG is also short for Interactive Diagenesis. Diagensis is "the recombination or rearrangement of constituents (as of a chemical or mineral) resulting in a new product, or the conversion (as by compaction) of sediment into rock (Webster's 1986)".

social barriers. Accordingly, our emphasis is less on the technical mechanisms for doing textual summarization or knowledge elicitation than on finding social models with augmentative technical mechanisms to foster the creation of material and then "boiling down" of that material into something that will be subsequently useful to others.

- These "boiled down" repositories are the distilled and refined versions of many people's thoughts about a subject, mostly likely specific to a particular socio-technical environment. We are also investigating mechanisms to foster the sustainability of this distilled repository over time.
- In any social space, mechanisms must exist to foster social regulation and sustainability over time (as in Ackerman and Palen 1996). While social regulation can have pejorative connotations for computer people, some amount is necessary to continue any collectivity's activities. It seems as though there are always problem or abusive users in online spaces. We also wish to prevent or ameliorate unproductive or hateful exchanges. As we will see, the duration for I-DIAG is very short. Nonetheless, there are still social regulation and maintenance issues to be resolved; indeed, some may be exacerbated by use assumed to be brief. Through I-DIAG we are investigating collaboration-centric mechanisms to quickly move users into an understanding of the system and its uses, enable productive exchanges, and control potentially unruly users and problematic exchanges.
- Since we hope that use is rapid and the corpus of information is constructed very quickly, we are investigating interface mechanisms to allow users to return to the space and understand what is new quickly and effectively. We hope to produce interface guidelines for these types of spaces.
- Overall, we see ourselves as investigating new forms of knowledge management. I-DIAG forms an interactive or dynamic "book", where the corpus is constructed iteratively and collaboratively by people with different opinions, types of expertise, and varieties of experience and viewpoints. This "book" is a living document – not only is it constructed by people in terms of their own interests and knowledge, but it can be maintained over time in the same manner.

Our major goal, then, is to understand how to iteratively construct a refined knowledge repository (probably less than completely formalized but more distilled than raw messages). To do so, we must necessarily also investigate what technical *and* social mechanisms we need for sustainability, social regulation and maintenance, navigation and return, and interface metaphors.

In order to examine these broad issues, we have created a particular problem scenario and the computational system to solve it. The scenario in the introduction describes most of the problem we are addressing. It is a "brainstorming system", a system in which people can come together to offer ideas and debate them. I-

DIAG, then, is the specific testbed we have created to investigate these issues. We have simplified our application and its environment:

- In keeping with the Internet philosophy of utilizing many eyeballs, I-DIAG attempts to harness small amounts of time from users. Motivations for using the system come from everyday activity. Within a given organization or community, we hope to have some small number of core users who will be key contributors, but we expect small contributions from a much larger number of people. At the end, we expect only a handful of people to distill the material.
- In our standard scenario of use, we are assuming the site will be used actively for a brief period of time – two weeks in our current plans. This allows people to have a healthy and vigorous discussion on specific topics, and then the site can close down before the topic becomes obsolete or stale. It also provides us a time to start mining the discussion as a final product – namely the final report and/or a distilled, concise web site of responses and ideas.
- I-DIAG, accordingly, has three sets of users. The first user group consists of the people entering their comments and discussing appropriate topics. In general, these people will be from a specific organization, institution, geopolitical community, or scientific community. The second user group consists of the moderators, editors, and wizards who control the interactive discussion. The final set consists of the people distilling the archived materials, either for an external report or to create a more concise site.
- The precise outcome of any given I-DIAG installation may not be known in advance. Some communities may wish a linear book as their outcome. The distillation process for a linear book would likely be different than when one wishes a concise site as the outcome. In addition, the scope of the distillation might vary – some sites may wish to include every point of view and every significant issue; other sites may wish to merely keep subdiscussions or interesting points.

I-DIAG, then, is an attempt to reconsider knowledge management and knowledge communities. It attempts to create incentives for use and reuse by differing groups of people, all of whom iteratively construct the space and the knowledge through their activities.

Relevant Literatures and Related Systems

Several diverse literatures bring appropriate insights and prior work.

Of direct relevance here are a number of approaches to distillation and summarization. In an older Education literature, one can find descriptions of "advanced organizers," organization tools for structuring educational lessons or

materials (Jonassen, Beissner, and Yacci 1993). Although over time, the term came to be known as a technique for textual or oral materials (similar to foreshadowing), originally these included visual organizers. These visual organizers included timelines, web of relationships, trees of concepts, and the like. Many of the visual interfaces are directly relevant to our efforts to provide organization tools to users; however, these visual interfaces, we feel, are only part of what is needed.

Similar in intent to the literature on visual organizers is an important research stream on incremental formalization (Shipman and Marshall 1999, Shipman and McCall 1999, Shipman and McCall 1994). Visual organizers allow one to slowly increase the amount of organization in one's material by presenting more conceptually-oriented views on that material. This idea has been generalized in Shipman and colleagues' hypertext work. These papers argue that one should consider how to allow incremental formalization over time: Users can enter free text initially and slowly increase the level of organization and formalisms in their material. By allowing them to choose how and when to formalize their material not only is the system easier to use, users are more motivated to provide material. Incremental formalization is critical to how I-DIAG works.

As well, I-DIAG uses techniques derived from and similar to text summarization. Text summarization (e.g., Radev and Hovy 1999) attempts to consolidate large documents or sets of documents into abstracts or shorter documents. They do this through partial natural language understanding, taking the material in a document or set of documents and creating an abstract or summary. Many of the techniques are relevant to I-DIAG, but again these techniques are only part of what is needed.

I-DIAG is related to a number of different Computer Supported Cooperative Work (CSCW) systems (also called collaborative systems here). I-DIAG is obviously an e-community system. E-communities have been largely studied for their social effects (e.g., Sproull and Kiesler 1991, Wenger 1998). Emphasis has been on the social norms of use (e.g., flaming in Sproull and Kiesler 1991), character formation (e.g., alternative personalities in Turkle 1995), and communications (e.g., shared language in Cherny 1995). Much of this research is summarized in Preece 2000.

These systems do not have a large technical research literature. There is a literature on group communications, which concentrates on low-level distributed protocols or on construction flexibility. There is also a literature on visualizations (Xiong and Donath 1999, Smith, Cadiz, and Burkhalter 2000). There is, however, a considerable practioner base and understanding, summarized again in Preece 2000.

Even fewer studies detail how the social and technical aspects of e-communities are related. Ackerman and Palen (1996) studied the Zephyr Message System, a shared chat system used at MIT. The study outlined the basic norm and

reward structures for the Help Instance, which is one Zephyr channel. Participants were able to use Zephyr, because of these social structures and a set of reinforcing technical affordances. Still, the Zephyr system was extremely simple, consisting of message scrolling by in a tty window. In the I-DIAG work, we are searching for additional, flexible types of support for e-communities.

I-DIAG also has similarities to a variety of brainstorming systems that have been investigated over the years. Generally, most such systems have been deployed and studied within face-to-face and distributed work meetings. Group support systems (e.g., Nunamaker et al. 1991) and meeting support systems (e.g., Streitz et al. 1994), to our knowledge, have been limited to either single-session meetings or small groups. They suggest, nonetheless, the value in computer support for brainstorming. A number of studies have shown that the use of these systems provides more ideas and more creative insight to a problem (Dennis et al. 1999). However, since the use of these systems has been limited to single-session meetings, little has been studied about the social structures of use over time, or the technology and human-computer interface mechanisms required to support that use over time.

One large-scale brainstorming system reported in the research literature was the White House 's Open Meeting on the National Performance Review (Hurwitz and Mallery 1995). Using the system, users "discussed, evaluated, and critiqued recommendations by linking their comments to points in the evolving policy hypertext." The message were typed according to an ontology, forming the potential basis of a discussion distillation. However, it is not clear, from the paper, that any further work, such as distillation, was done with the messages.

Indeed, evolving discussions of the sort in Hurwitz and Mallory or in I-DIAG could serve as a rudimentary design or decision rationale system (Conklin and Begeman 1988, MacLean et al. 1990, Moran and Carroll 1996). In a decision rationale, users categorize their points according to an explicit ontology concerned with discussion, technical design, or decision-making (e.g., gIBIS in Conklin and Begeman 1988 or QOC in MacLean et al. 1990). This is combined with an implicit social process in order to create a coherent, well-structured argument that can be viewed by others at a later time. The goal is to help future readers understand a decision or design, and perhaps reuse portions of the rationale in their own subsequent design or decision processes. However, as Grudin points out in Moran and Carroll (1996), users must do considerable upfront work for an unclear future payoff. Indeed, most attempts to use rationale systems show that users are reluctant to go to the extra work to construct detailed, formalized rationale arguments. Accordingly, I-DIAG attempts to provide suitable incentives for all of the users of the system by separating the argumentation from the distillation. The message database in an I-DIAG installation is created because users want to discuss a problem; the users do not have to categorize their messages according to an ontology or create overly detailed arguments. Users can

then incrementally formalize the discussion, as will be discussed below, and editors can later distill. I-DIAG discussions will not be as complete as design rationale arguments, but we believe I-DIAG discussions are more likely to appear.

Finally, in our own earlier work, we examined collaborative systems for the distillation process. Answer Garden 2 (Ackerman and McDonald 1996) included the Collaborative Refinery (Co-Refinery), a system to support the refinement of messages and other raw information into frequently-asked quesitons (FAQs). Co-Refinery followed a process based on libraries' collection management processes (Gardner 1981, Osburn and Atkinson 1991). There were four steps. Collecting was the phase in which information is gathered into a collection, and culling was removing superfluous or redundant material from the collection. Organizing was the phase in which the materials were grouped according to some classification scheme (even an ad-hoc one). Some form of organization was a necessary precursor to distillation and to later retrievability. Distilling was the phase in which existing material was boiled down into shorter or more substantive materials. Each of these phases was considered a separate activity, and each was considered independently valuable. It was also assumed that any of these phases could be done iteratively or in any order. Co-Refinery supported organizing and distilling the materials. I-DIAG takes its beginning point from Co-Refinery and its mechanisms.

In summary, considerable work has been done on creating, fostering, and governing e-communities. Systems have also been created to foster and support brainstorming and decision rationale on-line. However, there has been little work, to date, on distilling informal information, especially group brainstorming results.

Architecture and Services

Differing users and their tasks suggested multiple applications, rather than trying to do everything in one Web-based application. For the discussion portion of I-DIAG, the interface requirements are relatively low. A Web-based interface could handle those requirements, and so we could consider customizing one of many Web-based discussion systems. On the other hand, there are substantial interface requirements for interactively handling sense-making, collaborative, and ad-hoc representations of complex intellectual spaces. As we found in the Co-Refinery (Ackerman and McDonald 1996), Web-based interfaces would likely be marginal.

Therefore, we constructed I-DIAG instead as an environment into which new applications and auxiliary agents can easily be added. The architecture allows a gradation between user-controlled applications and autonomous agents. The architecture is shown in Figure 1. As many Web-based applications have, I-DIAG has a database at its core. For I-DIAG, the database stores largely hypermedia objects as well as meta-data. Applications (discussed immediately below) and agents feed to and from the database. As new services are developed, they can be

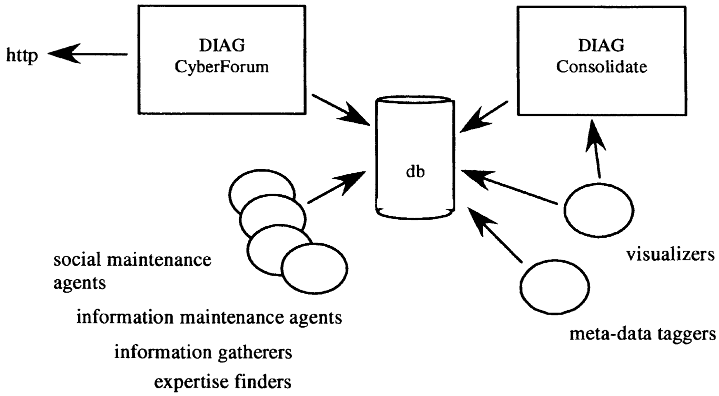

Figure 1: I-DIAG architecture

placed into the architecture easily. We expect some of these services and applications to consist of relatively standard software projects; others will consist of research prototypes.

The following two subsections describe the two major applications that provide the basic functionality of I-DIAG.

CyberForum

The front-end, discussion service is called I-DIAG/CyberForum (CyberForum). CyberForum is a typical Web discussion site. This application is absolutely essential to solving the scenario problem described in the introduction, since all discussion occurs within it.

Figure 2 shows the CyberForum home page. The home page shows the most recent posts. On a normal topic page, it would show the messages for that topic. These messages are threaded, as is normal in similar systems, and are shown to a user-settable depth. Figure 3 shows part of a discussion. At the top of the main area is a summary; summaries „roll up" part of a discussion. (Summaries will be discussed more fully below.) On either side of the page are small boxes that contain information, links, and program actions for the user. The type of boxes and actions are dependent on the user's level, and they can be customized by the user.

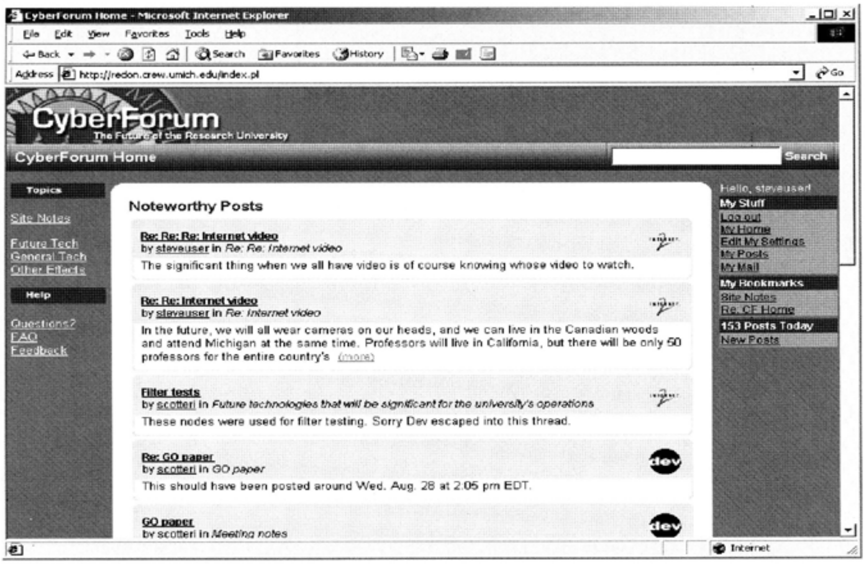

Figure 2: CyberForum home page

In addition to the basic CyberForum engineering, several research problems had to be addressed. As mentioned above, at a social level, we wished to consider collaborative mechanisms to facilitate social interaction and regulation. Because CyberForum is intended for relatively short-term use – a few weeks or a month for a particular site – the system has had to be optimized not only for performance efficiency (as does any Web application) but also for *social maintenance*. Social maintenance includes how to motivate users to come to and continue to participate at the site (*social facilitation*[2]) as well as how to deal with problem users (*social regulation*). We will discuss the mechanisms to support these requirements in detail below, but briefly, we added:

- Facilities to allow people to easy come in and out of discussions. In order for users to return to the site over time, it is important for them to be able to easily determine the current state of discussions as well as see what is new.
- User facilities to see what messages someone has posted. This not only provides a motivation for users to post, it also allows some pre-processing for later distillation. Moderators can highlight interesting posts for other users. Moreover, they can annotate, discuss, or merely note interesting posts for later examination.

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[2] The social facilitation effect, in social psychology, occurs when people are motivated to act because others are acting similarly. Examples include going to well-populated restaurants or, negatively, not rescuing a crime victim when no one else does. However, we use the term in a more general sense to include all manners of facilitating long-term social interaction in a collectivity.

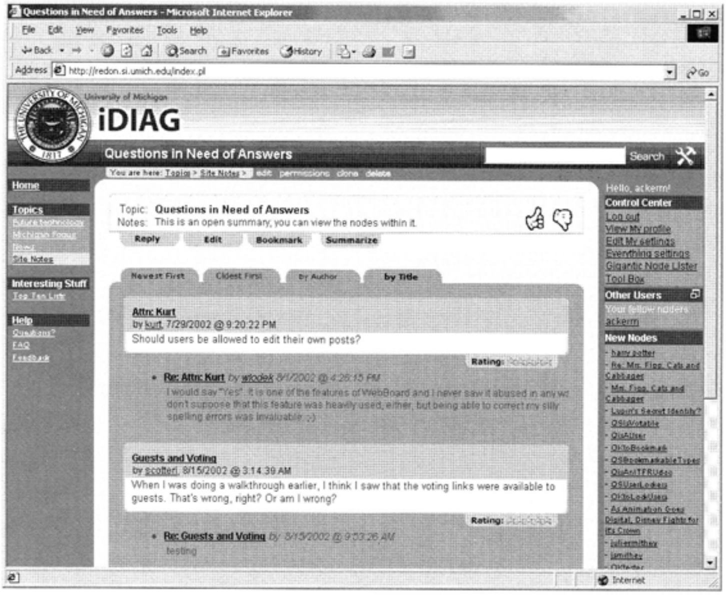

Figure 3: Summary in CyberForum

- Summaries to close problematic discussions. Summaries can provide a visual consolidation with further discussion allowed, a closing-off of further discussion, or a conclusion to an extended discussion.
- Agent-based mechanisms by which message traffic can be monitored for problem users, spam, robot posters, and the like.

These will be discussed further below. We expect to add additional services to support the social requirements as we use CyberForum in limited field tests. Recently, we have begun to make our rating mechanism more flexible, especially with regard to the visual indicators for a message's rating by other users.

CyberForum is an application based upon the open-source Everything2 engine (essentially the same as that used by the Slashdot site). The Everything2 engine provides CyberForum with the capability for message creation, editing, and storing. The Everything2 engine also provides support for constructing displays, linking, and threading. It should be noted, however, that the effort of constructing the CyberForum application was still substantial; the raw engine provides only the basic underlying services. CyberForum is currently 40,000 lines of code in addition to the Everything2 facilities. (Everything2 is substantially smaller.)

As well, to support our problem scenario, we had to add two major facilities to the Everything2 engine in order to create our computational architecture. In order to have external agents, we added a SOAP interface. Everything2 out of the box does not support communication with external programs. This facility gives us many additional capabilities. To facilitate the social processes around editing and

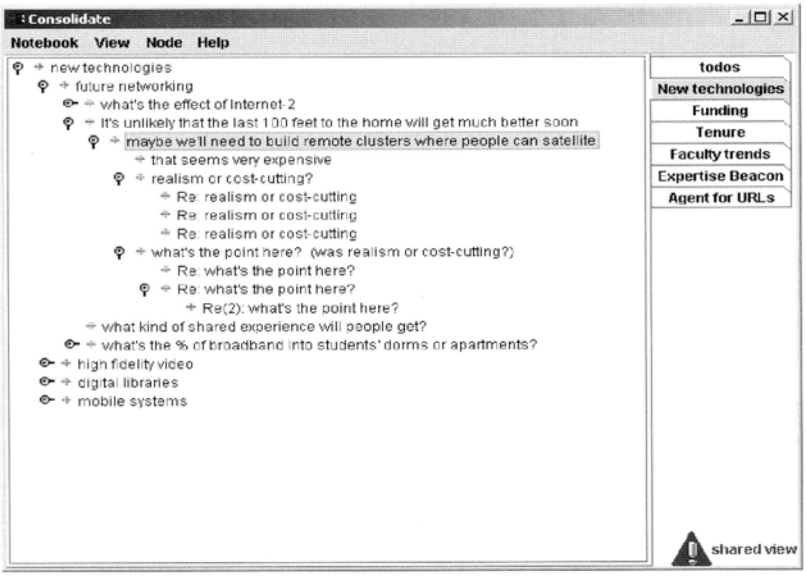

Figure 4: A Consolidate viewsheet

moderating of messages, we added a base layer of process support. This process facility is critical to our efforts at social regulation and maintenance.

Consolidate

The second major application in the I-DIAG environment is I-DIAG/Consolidate (Consolidate). Consolidate, in our scenario of use, will be used by experts to consolidate and distill the messages and organization of the site once people have finished with CyberForum. Consolidate consists of an extremely flexible core system that ties together extensible views, a query service, and visualizations of the information (in this case, messages, threads, topics, and people) and its structure

Consolidate provides for collaborative use through shared views. The data for these shared views can be handled through a variety of replication engines; currently a simple replication scheme is supported. Through the shared views, multiple editors can discuss and consolidate differing organizations of the raw information. Multiple messages, as well as additional information (e.g., editor notes, links to external references), can be consolidated into summary nodes. Figure 4 shows an outline view of a topic; the icon in the lower right corner (which is normally in red) signals that this is a view shared with others.

In Consolidate, editors can place messages into multiple topics or even rearrange the topics themselves. While Everything2 and hence CyberForum-requires that all messages have only one parent, Consolidate does not. This is particularly important for knowledge distillation. Nodes can clearly be about

multiple topics. In addition, editors may wish to keep their own lists of interesting nodes, nodes by certain people, and other kinds of working lists.

In addition to views of the information, Consolidate contains a query service used to find new relationships. The query service currently allows users to retrieve based on topic, date, keywords, and author. We believe that a major use will be retrieval by author. Many times one finds an unusually perspicacious or even offbeat author, and wishes to find other postings by the same author. In the future, we plan a "reduced keyword" query based on latent semantic indexing. In this query, both the message space and the query are mapped to an approximately 100 dimensional space; this can improve retrieval, especially for short messages.

Consolidate also contains a number of semi-autonomous agents. Some will be used to crunch visualizations of the messages. Editors must search for outliers, either to eliminate them from a consolidated site or to make them prominent because they have novel or offbeat ideas.

Social Maintenance Services in I-DIAG

As mentioned, our concern in CyberForum is in finding new technical facilities for social maintenance and social regulation. E-communities to date have largely relied on social norms, reward structures, or other social structures to maintain and regulate themselves. We recognize the efficacy of these solutions; yet, efficiency and cost suggest examining potential technical augmentations. The cost of regulating problem users can be prohibitive. Accordingly, we are examining three technical mechanisms to help the people running a CyberForum. They range in level of augmentation. The facilities are summaries, used to control problem discussions; social maintenance agents, to watch for problem users and other social problems; and, governance objects, to radically alter the social structure of a CyberForum if required.

We cover each in turn.

Summaries

The first facility is summary nodes. As described briefly above, summary nodes „roll up" a subdiscussion. As a summary, they can include straightforward text summaries created by hand or through software or both. Summary nodes serve to visually signal to the user that a block of related messages exist, but they need not be read since the summary is available instead. As such, they are largely visual indicators that a conclusion or partial conclusion has been reached. The internal text can link to specific messages if more detail is required or to serve as citations. Most importantly, summaries allow incremental formalization. Moderators or editors can slowly distill discussions while the discussion is ongoing.

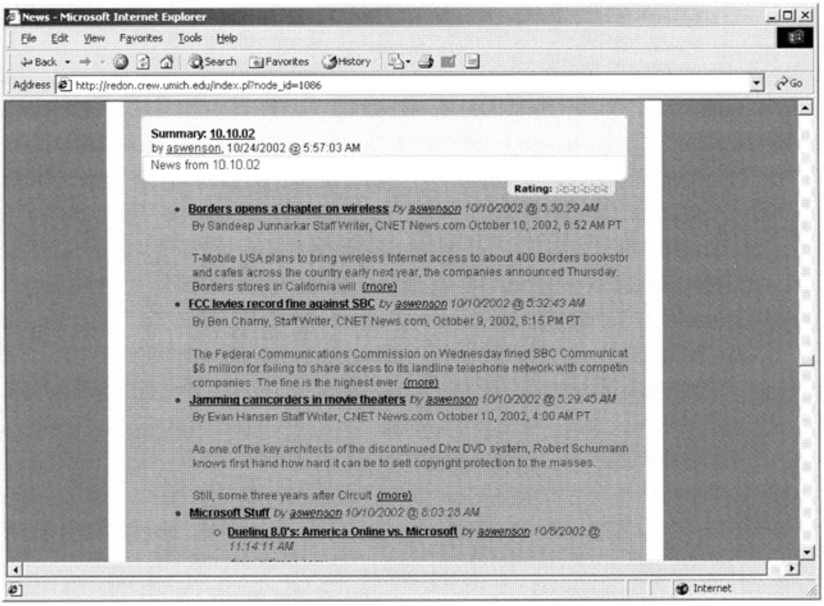

Figure 5: CyberForum summary

In addition, however, we created summary nodes to augment regulating further discussion. We needed to not only provide users with some mechanism to reduce visual overload; CyberForum also required some mechanism to forestall problematic conversations. Some debates are endless. Debates like „is the Macintosh better than the PC?" can easily erupt in an e-community. (In our problem scenario, a similar debate might concern „what is the best fraternity?"). Summaries provide a mechanism by which a system administrator or a moderator can gently push users along by rolling up this argument, briefly summarizing it, and pointing out the intermittable nature of the discussion.

More importantly, while the endless debates are annoying, some debates can be socially destructive. CyberForum needed some mechanism to close off socially problematic arguments while not becoming overtly censorial. Some people post so-called „flame bait", messages critical of minorities, women, lifestyles, or nationalities. Messages arguing, for example, that „some minorities get unfair breaks" will serve their purpose, to draw attention to the writer. They can even create long-running arguments. However, these arguments are often organizationally dysfunctional. In the above example, a minority user will likely feel alienated, no matter how the debate ends. These arguments can create discord throughout the larger community, which is certainly against the purpose of I-DIAG. Accordingly, CyberForum summaries can be closed, disallowing further discussion. When summaries are closed, they serve as a statement by the system administrator or topic moderator that the discussion should be avoided. Figure 5 shows one of these closed summaries.

While simple, summaries are surprisingly useful socially.

Social Maintenance Agents

As mentioned, I-DIAG also includes sets of semi-autonomous agents. We have created a set of agents, and their support environment, to monitor social conditions inside CyberForum. Because of the programming environment of CyberForum, a result of its underlying Everything2 engine, it is necessary to run these agents outside of CyberForum. Nonetheless, we believe this type of facility is generalizable in that it would be useful in any e-community system.

Nodes (i.e., CyberForum messages) are written out as they are created. The nodes are sent asychronously to avoid locking problems. The nodes are read in by the agent environment, parsed, and placed on an internal blackboard for further processing. (Blackboards are persistent tuple-stores, often used in agent architectures.) This blackboard can be read by any agent, and any agent can write partial results onto the blackboard for other agents. The environment can be periodically snapshot to storage for persistance.

Currently, we have implemented three agents. The first checks for flames by scanning a message for inappropriate words. This agent can also look for problem phrases. When a flame or problematic posting is detected, a message is sent to the appropriate editor or moderator in I-DIAG. Human intervention is necessary since the language may have been appropriate to a particular discussion.

The second agent watches posting rates. With unusually high volumes, the agent signals that a robot attack may be underway, and locks out the user. With moderately high rates over time, the agent signals the system administrators that this user should be acknowledged, sine this user is one of the mainstays of I-DIAG. The agent also notes when a low usage-level user has returned to I-DIAG after a hiatus, currently set to two days.

The final prototype of a social maintenance agent notes when discussions are active or inactive. If a discussion is currently active, it sends a message to the appropriate moderator or system administrator. This person can then foster the discussion, adding comments for example. Alternatively, the agent can also note that a particular discussion has been inactive, especially if the system administrator or moderator has indicated that the discussion is not yet closed. Action can then be taken to draw the participants back to the discussion.

These agents only scratch the surface of what will be useful. We will uncover additional agents as we go through our field tests.

Governance Objects

E-communities or other virtual collectivities, like any other sociality, must have norm structures, membership structures, and other ways of governing themselves. At present, little support is provided through technical mechanisms for these social structures. Indeed, technical mechanisms that have been tried, such as floor control (Rein and Ellis 1991), have been too awkward to use effectively.

Elsewhere, we have argued (Ackerman 2000, Ackerman 2001) that there is an inherent gap between what we need to support socially and what we can facilitate technically: These social structures are inherently flexible, nuanced, and tolerant of exceptions, whereas our system mechanisms tend to be brittle, rigid, and standardized. Unfortunately, leaving everything to communication backchannels and people working out norms leads to substantial time loss and social breakdowns.

Governance objects (GOs) are an attempt to find a suitable work-around or approximation. We draw our inspiration from Hollan and Stornetta (1992). They argued that computer-mediated communication (CMC) would never be as good as face-to-face communication, and that comparisons of computer-mediated to face-to-face behavior would always be disappointing. They argued instead that the telephone, although inherently inferior to face-to-face communication, had an important characteristic that face-to-face did not. The telephone could be used for communication over long distances. Despite the telephone's inferiority, people not only tolerated but accepted it, because communication was good enough and because the communication went „beyond being there".

Similarly, GOs are an attempt to use the advantages of computational mechanisms while acknowledging their limitation. Computational mechanisms to facilitate governance can never be as good as human forms of social interaction and social understanding. However, perhaps computational mechanisms could add something impossible in human interaction. Accordingly, the goal for GOs has been to allow people to quickly instantiate collective forms of governance. While users lose the flexibility and nuance of human interaction, they gain the flexibility of easily changing many rules simultaneouly – something impossible with „normal" social interaction.

GOs work essentially as templates, and users can quickly move among them.

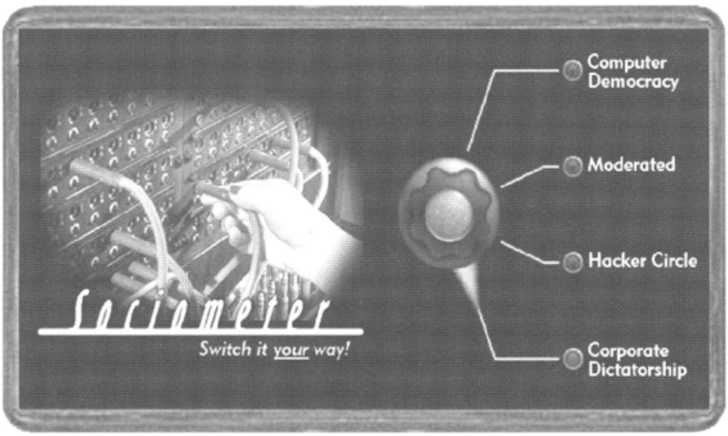

Figure 6: Governance objects as installed in an interface widget

A mockup that best describes our goal for GOs can be seen in Figure 6. In this interface, the user can quickly switch from „computer democracy“ (where anyone can post) to „moderated“ (where a moderator must vet postings first). Governance styles also control membership rules. In a „computer democracy“; anyone can join and post; in a „corporate dictatorship“, the manager can unilaterally decide to let users join or force them to leave; and, in a „hacker circle“, a vote allows people to join, but only in a probationary role. Of course, some GO transforms require additional input. For example, the name of a moderator must be provided for the covered topics.

We have implemented GOs twice in CyberForum. The first implementation assumed the priority of GOs. Each operation for each role in the system had governance-controlled access. The centrality of governance, however, came with a cost: Because of the code arrangements in Everything2, the display code was duplicated extensively. Our second implementation centralized the display code, but now the governance code is heavily duplicated. Since Everything2 is not object-oriented, there is essentially no easy way to conserve code – either governance or display will be duplicated extensively. Despite this, however, GOs (in reality, governance mechanisms rather than governance objects) appear to work. We can quickly change a number of governance rules at both the system level and at the topic level. This will be invaluable for large-scale implementations of I-DIAG, since it will be important to be able to switch among free-form and moderated discussions. In addition, we envision other important uses for GOs; for example, to provide the capability to have scientific-journal editor boards or other forms of oligarchical, expert regulation.

Implementation

Currently, as mentioned, CyberForum consists of over 40,000 lines of Perl code, over and above the base Everything2 engine and our extensions. CyberForum requires the Everything2 open source engine, a MySQL database, an Apache Web server, and Debian Linux. The social maintenance agents and the agent environment are written in Java. The code for each agent is rather minor; the largest is several hundred lines of Java code. The agent environment is approximately 3000 lines.

I-DIAG/Consolidate is constructed in Java and Jython, the Java implementation of the Python language. (Consolidate uses Jython as both an internal scripting language as well as a scripting language for user-created agents and user-modified views.) Consolidate currently consists of approximately 16,000 lines of Java code. Consolidate runs on any Java platform; it assumes the MySQL database or a connection to a Web server for the CyberForum nodes.

Only CyberForum is ready for full deployment. We are currently testing CyberForum in a limited field study consisting of two University of Michigan

classes. Our preliminary results appear encouraging. Students are using the system. (We have limited field data to date, because of privacy controls.) The classes have posed several new requirements. The most important requirement has been the capability to place static documents within discussions. This capability will be useful for our problem scenario as well; it is often useful to have joining a discussion first examine a common set of reference documents or links.

We are planning a larger scale field test in the near future using both CyberForum and Consolidate.

Summary

I-DIAG is an attempt to create a suitable environment for a common knowledge problem – to bring a large group of people or an organization together to discuss and brainstorm a problem, followed by experts distilling the results into something meaningful and succinct. Both steps require technical facilitation and augmentation.

To meet these goals, I-DIAG requires a suite of applications and services. This paper has described I-DIAG's two applications – CyberForum, as the discussion application, and Consolidate, as the distillation application.

More importantly, to meet these goals, I-DIAG also requires a set of technical mechanisms to facilitate social maintenance, social facilitation, and social regulation. We need to motivate people to come to the site and to continue to use the site. We also need to control problem users and situations. The paper has described three technical mechanisms to augment social maintenance. All provide some support for social facilitation and regulation, although the amount varies. Closed summaries provide a basic level of social regulation, closing off problematic discussions, debates, and so-called „flame fests". Social maintenance agents search for problem users, as well as situations ripe for motivational reinforcement. Finally, governance objects (GOs) provide for quickly switching among sets of social rules, including social maintenance, membership, and authorship control.

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The Role of Knowledge Artifacts in Innovation Management: The Case of a Chemical Compound Designer CoP

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Abstract. The paper describes how the experience we gained in the interaction with a community of professionals, the Compound Designer CoP (involved in tire production), led to the identification of the role Knowledge Artifacts can play in the definition of computational supports of innovation management in the specific domain of chemical formulation for rubber compounds. The paper reports on an experience gained in a project we are involved in and on the technology that has been designed to support knowledge and innovation management in the involved company.

Introduction

The paper describes the experience we gained in the last years in cooperating with people involved in innovation processes at a specific industrial setting with the aim to develop a Knowledge Management (KM) project and deliver a computer-based KM support system[1].

[1] Truck Business Unit of Pirelli Tires; P-Truck Project.

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The aim of the project is the development of a Knowledge Management System to support the expert in their decision making about the *design of rubber* compounds for truck tires. The need of this support was phrased by the top management of the company both in terms of a better understanding of how innovation is achieved in the company in order to improve its effectiveness in front of market competitiveness, on the one hand, and in front of turn-over and new generation professionals in the organizational structure, on the other hand. This goal is fully in accordance with the trend that sees companies increasingly concerned with the *management of innovation* as a fundamental aspect of their ability to be competitive in turbulent markets (Prahalad and Hamel, 2000).

In order to tackle this problem and define the space of intervention to solve it, it is useful to recall how innovation is interpreted by these companies. Innovation loosed the characteristics of being a series of isolated events, generating revolutionary changes in products and processes, to become a continuous activity generating smaller scale improvements of both of them in order to answer the continuous request of new products coming from the market. Revolutionary innovation events are spots that are embedded and rooted in this continuous, permanent and pervasive activity. In this way, innovation plays a leading role in competitive advantage, as the core ability to create new products or significantly modify by adaptation products without ignoring production constraints. It means to valorize and exploit the core competencies owned by a company, namely focusing on its own core knowledge. Here, innovation management and knowledge management share the same complex territory.

In this view, an effective management of innovation is on the one hand fruitful to reduce the time to market of the innovative products and the related costs, but very challenging on the other hand. In fact, innovation is the result of the cooperation of skilled professionals owning valuable core knowledge, whose activities are dispersed in the business processes that cross the organizational structure in flexible ways. The emphasis on business processes and to the identification of technologies supporting them, that characterized the past decades, let companies pay less attention to the innovation process that, in turn, crosses business processes. Consequently, business processes and the related technologies are not able to support innovation management in an adequate way, although they often define the organizational and technological context in which it is generated. Hence, the understanding of how the innovation process happens and how it can be supported still requires new investigation and investments.

Actually, this was the leading idea of the P-Truck project. The construction of a technological support is one of the final goals. An equally important goal is to improve people consciousness of the mechanisms governing innovation in the company as a preliminary effort to make the technological support useful and usable within the company. The second goal deeply influenced the way in which the project was conducted. On the one hand, the main characteristics of the

innovation process in the domain of designing rubber compounds for truck tires a Pirelli were uncovered through a strong cooperative interaction with company's stakeholders. On the other hand, we didn't impose an a priori theoretical construction in the accomplishment of this interaction. In other words, we let the conceptualization be derived from the discovery of the mechanisms used to govern innovation. In so doing, we empirically recognized the role of two main concepts and how they are instantiated in the concrete situation: the notion of *community of practice* (CoP) and of *knowledge artifact.*

The following sections illustrate the above points. Specifically, we describe how a specific knowledge artifact has been discovered, designed (following a knowledge engineering approach), incorporated in a computational tool and used as a basis for the definition of additional functionalities as part of a KM system supporting the compound designers' CoP. The paper ends with the discussion of the next steps we are going to undertake to capitalize this experience towards a more comprehensive KM support as well as a deeper understanding of how the notion of CoP can play a role in this effort.

The method and context of innovation

The collection of the data necessary to achieve the goals of the project was organized in two different phases. First, a series of meetings were planned and organized as *learning sessions* where different managerial roles illustrated the main features of the product (truck tires) and the various phases in which their design and production is achieved. The audience was composed of members of the research team and of stakeholders who were increasingly identified as necessary to collect the required information. This approach testifies the kind of investment the company put in the project, in terms of both preparation and participation to the sessions by qualified managerial roles. These sessions played the basic role of creating a mutual learning process among the participants who actively contributed to build a common view of how innovation is articulated in their every day work. Second, the various managerial roles were individually *interviewed* to complete and deepen the specific aspects under their responsibility on the basis of incremental descriptions of the collected data constructed by the research team. In addition, the data collection was completed by observations in the filed. In the following, we outline the main features characterizing the product and its life-cycle in order to make the context of innovation at Pirelli more precise.

A truck tire is a chemical device made up of both chemical components and other elements (Cussler and Moggridge, 2001), In particular, a truck tire is composed of rubber compounds (the chemical part), that is responsible for all the thermal-mechanical characteristics of the tire, and metallic reinforcement, that provides the tire with the necessary rigidity.

The life-cycle of a chemical device is centered on the product innovation, in order to meet the requirements of evolving markets they are devoted to. In the case of truck tires, it is necessary to optimize several aspects that concur to the overall performance (e.g. tensile strength, resistance to fatigue and so on), the importance of each of them varying according to the kind of market the will be sold on (e.g. North America, Europe, etc.)

The life-cycle of a truck tire is made up of a procedure consisting of phases. The main ones are:

- *Design* of rubber compounds: a rubber compound is a blend of different ingredients, both natural (e.g., natural rubber) and synthetic (e.g., carbon black, oils, and so on), chosen with the goal of achieving predefined performances, such as tensile strength, resistance to fatigue and so on. The Design phase decides the composition of the blend, identifying ingredients to be adopted and their amount;
- *Mixing*: the ingredients must be suitably mixed in order to obtain a homogeneous blend;
- *Semi-manufactured production*: metallic reinforcements are added to rubber compounds, getting the different parts the tire will be composed of;
- *Assembly*: semi-manufactured parts are assembled into a semi--finished product, in jargon called green-tire;
- *Vulcanization*: the green-tire is "cooked" in order to give it the required thermal-mechanical features.

At the start of the procedure, very important inputs come from marketing and research while in the last phases the role of engineering is predominant. However, the entire effort can be best considered as a whole, carried out by interacting teams drawn from marketing, research and engineering departments.

This procedure is the key for the generation of innovative solutions: since it takes care of marketing inputs, and then of market requests, chemists, that in the case of truck tires design are called *compound designers,* are forced to think to new solutions for meeting them. Moreover, they are requested to find solutions that can be processed by machinery, so that their decisions in the design of products must consider process design aspects too.

The first phase of the tire cycle of life is very critical: compound designers must choose ingredients composing the blend in order to guarantee a low level of viscosity; otherwise, for instance, the blend could be not easily mixed. Moreover, compound designers must be able to quickly modify the composition of the blend, due to problems arising during the mixing or other following process phases, in order to save production times and costs. Compound designers activity can be described as follows: they start a new project to meet the request of marketing, or to change one or more performances of an existing product; then they produce a list of possible recipes and choose one of them after an evaluation of benefits (i.e.

they evaluate if all the requirements have been satisfied) and drawbacks (i.e. what kind of side-effects have been generated). During the evaluation, compound designers can decide that marketing proposals are not realizable: a few years ago, the marketing suggested that the production of colored tires could be a promising choice to extend the competitiveness on tire market. This possibility was rejected by compound designers, due to the necessity to add synthetic or natural pigments that could negatively interact with other, and more important, elements of the blend.

Since the following phases of the life-cycle concern the manufacturing of the rubber compounds, compound designers takes care of this issue, avoiding to increase their level of viscosity (that could make the blend difficult to be mixed) or to let chemical reactions among ingredients happen too early or too late.

The above description shows (and confirms) that innovation is a continuous process (*continuous innovation* involving both product and production processes modifications) that requires the involved professionals a problem solving capability that is deeply rooted in their skills and *experiences*. Their experience is derived from the direct application of knowledge in problem solving on a specific competence domain, and allows them to structure explicit knowledge and to accumulate tacit knowledge. Experience means having dealt with several *cases* during time, regardless whether successful or not. Any solution that can be invented by applying professional skills has to be checked against the organizational, production, managerial context characterizing the company. Optimal solutions from the first point of view can be simply impractical from the second point of view. Moreover, this check requires the skills and experiences that are collected and put at work in different business processes. The main question to answer was how continuous innovation can happen in presence of a not specifically focused institutional support. In fact, the latter is often based on face-to-face meetings that of course are fundamental for the creation of the mutual understanding necessary to the collective problem solving activity and to the solution of the inherent conflicts. However, meetings are not able to create a persistent support to innovation management since they are oriented to plan future actions and not to record the experiences generated in between them. Moreover, they are often formal steps that have to be planned in advance (especially in a dispersed organization like Pirelli), they collect representatives of the whole set of involved professionals, and serve the mixed aim to promote solutions and check them against the requests of the market and the overall goals of the company. Hence, usually the real cooperative problem solving happens outside and is based of mechanisms that are invisible and self-organized.

Identifying a Community of Practice

The notion of Community of Practice (CoP) naturally applies in the above context since it explicitly focuses on practice, that is experience, and on the above officially unrecognized and self-organizing capability. This immediate correlation however, may crash with the difficulty to identify the *boundaries of the community* itself. This is necessary not to raise barriers since openness is a basic property of a CoP but to characterize it in order to identify the organizational and technological means that are most adequate to support the innovation process the CoP is involved in. The difficulty we meet in using this concept was generated by the following factors. First, looking for a shared "practice" without an identification criterion of the CoP itself can generate a sort of "domino effect", paradoxically including the whole organization. Second, people are not always conscious to be part of a CoP and are very influenced by the formal structure of their company: hence, they often tell their experiences in terms of the latter and the involved processes, although they recognize the existence of a "parallel" cooperation structure.

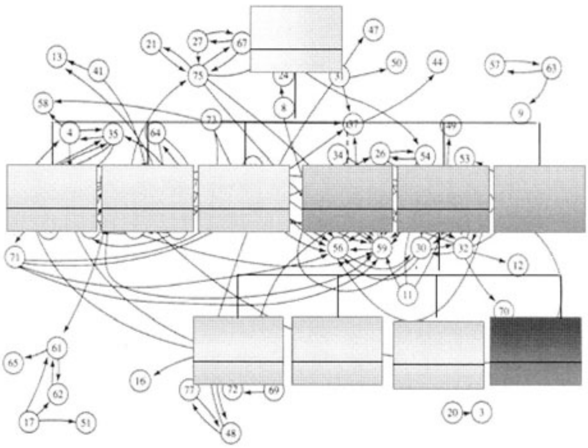

Figure 1: The synergy relation between Formal structure (the hierarchical boxes) and Informal Systems (Communities of Practice) (Katz, 1997)

Figure 1 shows a picture used by a stakeholder during one of the sessions to illustrate, in qualitative terms, how he perceived this synergy. Within an organization it is possible to recognize a formal structure (the stained hierarchical boxes), that characterizes its behavior and strategy, and an informal system (the graph), the *CoP Context,* which is made up of a network of social relationships among people living and working in the organization. Finally, the mechanisms supporting the latter are immersed in the practice and too ready at hand to be consciously perceived, being generated for practical purposes and not to build a

control structure.A possible way to tackle the problem of the identification of the *boundaries of the community* (in order to find new approaches in innovation management) is to look for the means by which people collect their experiences, organize the related pieces of knowledge and make them sharable. To this aim, it is useful to consider a Community of Practice (CoP) as characterized as *a group of professionals informally bound to one another through exposure to a common class of problems, common pursuit of solutions, and thereby themselves embodying a store of knowledge* (Hildreth and Kimble, 2000). This definition implies the existence of a *shared repertoire* among the members of CoPs, that is a set of methods, tools, ways of doing things, gestures, symbols, and so on, produced by the community during its existence.

Looking at the features of the shared repertoire we recognized it as characterized by a *professional language*, used in two very important ways:

- *Locality*: the language is adopted by each member of the CoP for speaking to another one;
- *Boundary*: the language is adopted by the whole community to communicate with other communities.

Both kinds of usage are fundamental and emerged during the "learning sessions". In fact, if a CoP would use a language not characterized by boundary it would be isolated within the organization, with no contribution to the organization's growth; on the other hand, a CoP couldn't exist if the locality principle would be negated, since there would be no sharing of experiences and competencies among its members. The professional language spoken by compound designers is strongly oriented to boundary, since they have to interact with other CoPs (e.g. other professionals working on Mixing or Vulcanization phases) in order to design rubber compounds that can be easily processed. On the other hand, their language is oriented to locality as it incorporates the knowledge and the methods they use in their cooperation.

Although the locality and boundary principles of CoPs' languages are well known from the theoretical point of view (see for instance Smethurst, 1997) there are still few efforts in the development of tools and methods to support them. During the interaction with the compound designers, we discovered that the professional language they developed was used to give a structure to their shared repertoire thanks to the *well defined syntax and semantics* characterizing it, although in an often implicit way.

Starting from this structure, looking for who contributes to it maintenance, identifying whom is accessing it and when, we claim, is a constructive way to identify the community whose practice is stratified in the structure itself. In addition, this is a very natural way to let people become aware of participating to the community they (possibly, unconsciously) contributed to build. This is consistent with Wenger's description (Wenger, 1998) of the dynamics that regulate the identity strengthening within a Community of Practice: the legitimate

participation of the members to the negotiation inside the community, takes place through the sharing of a common repertoire. The awareness of belonging to a CoP through the sharing of the repertoire, and most importantly its structure, let the involved people tell their *stories*, (namely narratives arising from experiences and cases) increasingly in terms of community, by stepping away from the formal structure, and coming back to it, when necessary, to understand the constraints and affordances the formal structure provides the community with.

The emergence of a knowledge artifact

A deeper investigation of the above structure let us make explicit the way in which the professional language was used to construct it and to envisage a way to support its formalization and usage.

It is a common practice that people, spontaneously and often implicitly; identify structures that make their cooperation and problem solving activities more effective. When these structures are sufficiently worked out and put at work, they are usually materialized in *artifacts* (conceptual, linguistic and/or modeling tools, whose structure is strictly shared by the members of a well defined community), which incorporate a language that is collectively understood and provides sufficient information to be useful for sake of mutual understanding and cooperative problem solving (namely, a "formal" jargon of a community, comprising very precise syntactic and semantic rules and conventions).

The role of artifacts in coordination is well recognized (e.g. see Heath and Luff, 1996). They are informational structures describing the current state of affairs in terms of responsibilities, current activities, plans for future actions and so on, and support the coordination in a group of cooperating actors. Let us call them *coordinative artifacts*. They can also play the role of *boundary objects* (Bowker et al., 1997) living at the border between different groups (CoPs) and supporting the coordination of the activities performed by the actors constituting them.

The artifact identified in our investigation at Pirelli, called *T-Matrix*, shares several properties with coordinative artifacts but is constructed for a (slightly) different purpose: it objectifies the way people organize the memory about their experiences and the involved knowledge as a resource supporting their cooperative problem solving. It was natural to identify the notion of *knowledge artifacts* to characterize them and to distinguish them from the coordinative ones.

The term "knowledge artifact" has been proposed in (Seiner, 2001) as one of the basic components characterizing knowledge flows within an organization or a community. Our characterization of the term shares many of the properties this proposal identifies to describe the role of knowledge artifacts in decision making. However, it particularly focuses of the collective definition of the specific artifact, on the ad hoc nature of its usage which distinguishes it from other typical artifacts

like reports or data files, and finally on the goal to retain the experiential core knowledge that characterizes the "collective agent" defining and using it. In other words, our characterization is more strongly related to the notion of community of practice that in the above proposal where it is only marginally considered since the argumentation seems more oriented to organizations where the identity and mutual awareness of the participants in the knowledge flow are more shaded.

The knowledge artifacts we are considering still play the role of boundary objects but not necessarily across CoPs. They can play this role within the same CoP to mediate cooperation among actors with different professional skills and involved in different business processes, but anyhow contributing to the same goal within the innovation process: for example, to adapt components of a product or of a production process to the new requirements imposed by the market. The presence of a commonly identified goal is a complementary way to identify the CoP and to understand the nature of the practice that makes sense to it. *Knowledge artifacts* incorporate the core competences as well as the experiences of actors who are professionals skilled in possibly different disciplines, each of them characterized by a specific professional language. Notice that, even in the case the reference discipline is the same for all members of the CoP, the fact that people apply it in different business processes can give them a different perspective on the common discipline and on the language they use to express their competences.

The detail of the T-Matrix will be explained in the next sections. However, in relation to the theme of the identification of a CoP, it is interesting to observe how the language used to build it is related with the languages that are owned by each individual professional and reflect their specific competences. While the latter are rigorously used to solve (sub)problems in charge of each professional actor, the former is characterized by a (high) degree of *under-specification*: it describes technical aspects in a more qualitative way. This seems to be a common characteristic of languages incorporating conventions concerning knowledge as well coordination means. A typical example of this qualitative jargon is the one adopted by stock traders: by the use of simple gestures they are able to express quantitative and complex concepts about the trading of stocks that will be easily understood by colleagues.

Under-specification is a mean to have a not expensive management of the artifact avoiding details that could hinder mutual understanding without making the artifact useless. This accounts for the locality aspect of the language and consequently of the artifact we mentioned in the previous section. The capability to maintain this delicate equilibrium is the very asset of a CoP and distinguishes its legitimate members from the peripheral ones. Competences and experiences allow the former to use the knowledge artifacts in an effective way, by interpreting the contents provided by other members and by reformulating the

under specified information in terms of their own rigorous professional language in order to put it at work in the realm of their responsibility.

It is also interesting to observe that under-specification accounts for the boundary aspect of language and artifact. In this case, under-specification is what makes the language and artifact usable across communities. It incorporates the enough information to make communication and cooperative problem solving possible. Interpretation does not require a full understanding of what is behind, rather a precise understanding of the part of the meaning that has been negotiated. This role has been recognized in the case of coordinative artifacts too (Sarini and Simone, 2000).

The genesis of the specific knowledge artifact

As anticipated, the interaction with the professionals involved in the design and production of truck tires was organized in learning sessions and in individual interviews. Actually, the two modes were intertwined since we had a session for each phase of the overall design and production procedure and the interviews were conducted after each of them by involving the pertinent professionals. In the following we describe the lesson learned from this interaction and how it let to the identification of a specific knowledge artifact that became the basis of the interaction itself as well as of the final computational support.

About the involved knowledge

We had the chance to experience in a concrete situation how the management of innovation is actually a continuous process. In fact, most of the successful achievements in chemical formulation of rubber compounds at Pirelli (as in several others tire companies) are based on transformations of previously experienced compounds. In general, most of chemical compound designers work consists in deciding about how to adapt a product (compound) in response to a series of performances the compound is supposed to feature. It became immediately evident that in order to be able to make such decisions it is not enough to be familiar with general chemistry. What is required is a non-bookish competence which derives from anything but experience. In the acquisition and representation of the knowledge involved in this decision making, the trouble in grasping these competences lies in their own volatility and informality, what Nonaka (Nonaka and Takeuchi, 95) has called *tacit* and *implicit* knowledge. The fact that this knowledge represents one of the more precious as well as the more volatile asset of a corporation contrasted with the lack of any well established policy at the corporate level to facilitate its creation and recording: however, this is not a surprise in the case of companies that are characterized by a long history (as also the case of the company we analyzed does) in which generations of

experts transmit competences between them almost in an oral form or directly through the involvement of the next generation professionals in the current problem solving.

The above situation makes particularly difficult the acquisition of the knowledge used by the experts when they select the proper adaptation of an existing product, depending on the market demand. This action requires bridging the gap between different professional languages: the market speaks of performances, the people responsible for the production processes speak of various aspects of feasibility while the chemical compound designers respond in terms of chemical formulations.

Since the very beginning, we have realized how experts of chemical formulation take decisions on the ground of a series of criteria which cannot be immediately converted into any physical-mathematical representation. Such criteria – even though they are expressed in the language of chemistry – are expressed in terms of a *common concept model* in which chemistry is translated: the competences and experiences held by chemical compound designers define the significance and interpretation of chemistry and not the opposite. During our work, we have observed that compound designers use a *tacit concept model* which translates chemistry into a jargon depending on a qualitative value of usage. In order to grasp this model which is implicitly and very effectively used in expert's routine work, it is therefore necessary to make an attempt to read out the semantic code by passing through the decoding of the jargon used by compound designers. In other words, the acquisition and representation of the involved knowledge concerned the comprehension of the specific language of the team and how it was used in a partial representation of the concept model, a paper based artifact, used by compound designers during their work. In this exercise, we have coped with a socially compact reality unified not only by a shared goal (an optimal chemical formulation) but also and especially by a shared jargon which is typical of that group. We could say that practice gets into the world of chemistry through the concept model and the jargon conveys the sound to a series of meanings.

The "T-Matrix" and its role

Let us go deeper in the structure of the discovered and jointly improved knowledge artifact. The fundamental entities considered in designing a formal structure (whose name can be here synthesized in "T-Matrix") are *tire*, *recipe*, *blend* and *ingredient*. Formulations concerning rubber compounds - the object on which compound designers work on - are explained by recipes, that is lists of ingredients with related amounts. According to the jargon used inside compound designers recipes (i.e. the object of domain problem) are structured on the basis of three main concepts: *family, combination and system.*

Each ingredient can be considered an element of a set whose items are characterized by common physical and chemical properties: this set is called *family* and each ingredient can belong to exactly one family. A set of attributes is associated to each family for describing its ingredients. Examples of ingredient families are Natural Rubbers, Oils and Carbon Blacks. A *combination* is a set of ingredients belonging to the same family: hence, elements of a combination are described by the same properties and play a similar role in the blend. Each recipe can be structured as a list of combinations. For example a recipe can contain a combination of natural rubbers, a combination of oils, a combination of carbon blacks and so on. Some combinations cooperate to give blend particular properties, both chemical and concerning the processability in following manufacturing phases: such combinations are grouped together in a *system*. Each system has a specific *role* within the recipe. For example, polymeric system is made up of rubber combinations, both natural and synthetic, and its role is to provide tire components with properties, such as elasticity.

Blends of rubber compounds are described by a set of Blend Features (BFs), such as tensile strength or hardness, while tires are described by means of Tire Performances (TPs), such as wet handling and mileage. As family attributes, BFs and TPs could be either qualitative (i.e. descriptions or comments given by experts) or quantitative (i.e. test results). In addition a set of interventions on the recipe (RIs) modify its composition.

TP 1	⊙↓	○↑	⊙↑	○↑
TP 2	▲↑	⊙↓	⊠	▲↑
TP 3	⊙↓	○↑	⊙↓	○↓
	BF 1	BF 2	BF 3	BF 4
RI 1	⊠	○↑	⊙↓	▲↓
RI 2	▲↓	⊠	○↑	⊠
RI 3	▲↑	○↑	⊙↓	○↓
RI 4	○↓	⊙↓	▲↓	⊙↑

Table 1: A T-Matrix example

The very important knowledge about chemical compounding for truck tire stands in two relationships, called Compounding Relation and Design Relation. The first relation binds RIs and BFs, while the latter describes the correlation existing between BFs and TPs. Instances of these relations are the reification of the experiences of compound designer CoP members. To describe the elements of these relations a vocabulary as been defined: it is made of symbols describing the correlation level and the proportionality of the involved items.

Table 1 reports an example of a T-Matrix containing compounding relations (upper part) and design relation (lower part). Symbols describing correlations and proportionality and their meanings are reported in Table 2. They represent the core meaning of the T-Matrix as a knowledge artifact.

	Symbols	Meaning
Correlation	⊙	Strong
	O	Good
	▲	Weak
	⊠	No
Proportionality	↑	Direct
	↓	Inverse

Table 2: T-Matrix symbols

It is possible to observe that the level of description of a very complex activity (such as briefly illustrated above) is summarized in a small set of "qualitative" relations among the components involved in the design of the blend. The very "poor" vocabulary represented in Table 2 is the core of the knowledge artifact allowing the CoP to share the essentials of their knowledge that is useful in compound design activity.

If you observe the CoP at work (as done in the knowledge engineering activity) you can see that the behavior of the members of the CoP reflects in a strict way the syntactic rules synthesized in the T-Matrix language. If some explanation is required by people not belonging to the CoP (the knowledge engineer or someone belonging to other CoPs) the language becomes more articulated and explanatory: the professionals come back to the language expressing their deep competences. For instance, the three values *strong*, *good* and *weak* are very qualitative in their nature. This doesn't mean that these values represent a shallow approach in the design of chemical compounds. On the contrary, precise quantities must be calculated in order to reach the right product to be obtained through this design.

The role of the components in the T-Matrix is not assigned on the ground of merely chemical requirements as owned by certain elements of the compound but it depends on their role within a production cycle of the compound itself. Thus, this role is strongly influenced by the way compounds are designed and by the experience gained in this specific production site. In other companies, the same chemical compound may play different roles and in any case would be described through a different concept model.

As we have remarked above, the innovative activity carried out by chemical compound designers at Pirelli consists of modifying previously experienced chemical compounds. In fact, their jargon is focused on compounds as organized in accordance with historically recognized classification criteria and in reference to possible actions on the compounds themselves. These criteria are reified in the T- Matrix which testifies a sort of practical learning on compounds – so different from theoretical knowledge of mathematics and chemistry – and is an example of representation of core knowledge acquired in the course of product innovation.

Moreover, the T-Matrix is the result of explicit disclosures transmitted by compound designers as chemists: therefore the T-Matrix is given an important value by members of this CoP. In fact, well-defined language identity, a shared language as molded to practice, dialogues and negotiations intended to cope with and discuss related matters, a shared documentary repertory come up as distinctive elements of the experts we have worked with. It was just during the work of acquisition and representation that they got aware of their own cohesion. Our mutual cooperation was enhanced by this constructive exchange. On the one hand, chemists were invited to show the rationale of their work in the field and consolidated their belonging to a community; on the other hand, we were given a chance to reflect upon an action of knowledge engineering within a community (we will come back to this point in the next section).

For what concerns the first aspect, to work with and be tightly close to this kind of social realities means to cope with an extremely informal way of working, which is transversal to the protocols governing the formal structure of the company. The T-Matrix is both a thesaurus of core knowledge and a conceptual instrument to assess the inclusion into a community: it defines a community through the representation of the jargon adopted within the community itself to perform negotiation of meanings. On the other hand, the interaction with compound designers brought to our attention that part of the knowledge involved in the negotiation activities within the community are, in fact, negotiated with members of other communities. An example is given by the role of a specific group of chemical elements producing the mixture for the vulcanization system, which plays a major role in a subsequent phase of the tire production process, namely the vulcanization (curing process). The vulcanization phase, in fact, imposes specific conditions on the chemical formula of the blend. Moreover, the knowledge about vulcanization incorporated in the T-Matrix expresses the boundary permeability between the community of vulcanization technologists and the community of chemical compound designers: the degree of permeability is given by an agreed upon jargon, although limited to the specific knowledge.

The T-Matrix as knowledge artifact not only formalizes a jargon and constitutes the linguistic code that defines a community of practice but also helps identifying the boundaries that define the relations with other communities that are possibly geographically separated (e.g. a tire chemical formula defined in Italy and maybe physically produced in Brazil).

About the design of a supportive tool

Before concluding this section we argue about the implications on the design of a technology supporting a CoP acting in the above scenario.

To give a stable and rigorous shape to a complex knowledge based on informality has pointed out an almost paradoxical aspect which characterizes the

work of a knowledge engineer. He is inevitably confronted with partial and incomplete representations of knowledge (Davis et al., 1993), which is a real limit for his work. On the other hand, reluctances and resistances as shown by experts while explaining the motivations leading to their decisions are interpreted as factors and symptoms of the solidity of the group. As an extreme case, if we would get experts say everything, if we would acquire the whole knowledge, we would require the community to lose its own identity and defenses. This way we would run the risk of making the community crumble and therefore the reason of knowledge engineer's work would definitively come to an end.

One of the findings of our experience regards a critical approach to the engineer's work especially if conceived within a CoP: it requires the formalization of knowledge which is often episodic and more often structured on practice and experience. The definition of a T-shaped matrix certainly implies a great simplification of knowledge required in the engineering of tire compounds. It is worth reflecting upon the fact that such a simplification reflects the contents of our interaction with the community. The T-shaped matrix may be considered as the outcome of what experts wanted to tell us about their work. Therefore it is a part of the reifications the community owns (Wenger, 1998) and from time to time the community goes back to in order to negotiate and participate as a group in the creation of meanings (Lave and Wenger, 1991). Reifications are normally taken as the final result of specific narratives and negotiations of meanings, but in our experience reification is a significant part of the knowledge involved in negotiation of the meanings themselves.

Since the innovation process is the place where core knowledge (competences and experiences) plays a primary role, the analysis of the target situation requires the competences of a knowledge engineer who possesses the conceptual and linguistic means to acquire and represent the relevant aspects of the domain knowledge supporting problem solving activities, and to construct computational tools accordingly. We recognized that the identification of knowledge artifacts has similar impacts on this construction as the identification of coordinative artifacts did have on the design of supports of articulation work (Schmidt and Simone, 1996). Specifically, it pushes the knowledge engineer to use her representation capability to respect the point of view of the "knowledge workers", to help them making it more explicit, to use conceptual and linguistic means to represent the needed under-specification, and finally to help them (especially, newcomers) in interpreting and using it in an effective way. Too often, the design of tools supporting the management of knowledge denies the value that under-specification has for the involved actors, and constructs for them an "ideal" support based on a rationalization of the discovered knowledge. Of course, computational tools cannot be ambiguous, but the awareness of the relevance of under-specification allows the design of supports that, interacting with the users,

recognize their unavoidable role in filling in the gap, in response to very specific contextual requirements.

KEPT: a Tool for Dealing with the T-Matrix

As anticipated in the introduction, one of the two goals of the project was the development of a knowledge management system supporting the management of innovation. The previous sections showed the main role of the T-Matrix artifact in supporting the CoP of the compound designers in the achievement of their main goal: the design of rubber compounds. Hence, it was natural to develop the knowledge based system on the basis of the knowledge it incorporates and the knowledge flow is supports. This results in a computer-based system integrating several knowledge based systems (KBS) that perform four basic functionalities: to *capture* (acquiring and maintaining) knowledge and *store* it in persistent way, and to *deploy* (sharing knowledge among users) and to *process* the captured knowledge, that is, the capability of the system (especially through its KBSs) to propose "optimal" solutions through inference based on the stored knowledge. Therefore the whole system is made up of three sets of software modules, built in order to provide the above functionalities. Accordingly, it is possible to identify a set of web user interfaces that perform knowledge deployment, a set of systems performing Knowledge Processing (KP modules) and KEPT (the Knowledge Elicitation module of P-Truck).

Specifically, we want to focus on KEPT because of its strict relation with the T-Matrix. Moreover, even if it is specifically involved in knowledge capturing and storing it has an important role in all the other functionalities (both knowledge deployment and KP modules that need to retrieve knowledge from KEPT to provide their functionalities). Thus, KEPT is a relevant support of the daily work in the Truck Business Unit both when it used as a stand-alone module to share and store knowledge and when it is implicitly used by other modules of P-Truck (for instance the KP modules incorporating the rule based system supporting compound designers).

Knowledge, such as compounding or design relations, is treated in KEPT using the same language of the T-Matrix. Since it is focused on the acquisition and maintenance of knowledge, it allows compound designers to manage (adding, removing or modifying) knowledge items (tire performances, blend features and recipe interventions) and relations among them (compounding and design relations). To this aim KEPT incorporates a formal model of the involved knowledge, the Abstract Compound Machine (ACM), described in (Bandini and Manzoni 2001) as the underlying computational mechanism supporting the implementation of the T-Matrix. The choice to use the same language of the knowledge artifact also in the software tool has been done in order to keep the locality and boundary roles of this language, that have been described in the

previous sessions. Hence, using KEPT it is possible to share knowledge both among compound designers' CoP and with members of other CoPs that are able to understand T-Matrix too. In fact, each compound designer can access the developed framework by mean of a web-browser to consult and update its knowledge base; on the other hand members of another CoP, such as mixing process designers or vulcanization experts, can obtain the desired information, for example, about ingredients role inside the blend formulation and their influences in the mixing or curing phase.

One of the main tasks of the whole knowledge system that is constructed around the T-Matrix knowledge artifact is to embody in a hidden way the translation from the qualitative values it contains into good and rigorous metrics so that knowledge can be processed in KBS to support experts in their daily activity. An example is the rule based system aimed to propose intervention on a recipe in order to achieve the desired features of the blend. Through this approach the whole knowledge based system plays a double role: it allows the sharing of the basic core knowledge (by the adoption of a common knowledge artifact), and the representation of the deep and formal knowledge to be capitalized in the system to support other functionalities. Since the emphasis of this paper is on the qualitative aspects characterizing the knowledge artifact of the considered CoP, the other aspects of the system have not been considered here.

Conclusions

The paper described how the experience we gained in the interaction with a community of professionals, the Compound Designer CoP (involved in tire production), led to the identification of the role Knowledge Artifacts can play in the definition of computational supports of innovation management in the specific domain of compound chemical formulation.

The need to acquire and represent the involved core knowledge focused our attention on a specific knowledge artifact, the T-Matrix, the compound designers created to identify and record their stratified and historically accumulated experiences and competences in the industrial case we presented. Moreover, this artifact allowed dealing with the identification of the boundaries of the compound designer CoP in terms of the capability to interpret and use the knowledge represented in the T-Matrix. This happens despite of the fact that the incorporated language expresses knowledge in a qualitative way and with a high degree of under specification with respect to the rigorous languages this class of professionals use in the accomplishment of their specific tasks.

The T-Matrix is incorporated in KEPT, a software module that is part of more comprehensive KM application developed within the illustrated project. KEPT supports the innovation management according to the actual practices of the

identified CoP and allows other professionals of the company to share these practices and the concept model created to capitalize them.

Moreover, the conceptualization objectified in the T-Matrix structure is used as a basis for the implementation of additional functions. Specifically, it served as the basis of the conception of a module supporting the learning process of new professionals joining the compound designer CoP in consequence of an increasing level of turn-over.

Our future work is about this specific functionality in order to take into account the learning process going on in this community, as a fundamental aspect of its effective functioning and survival. The educational approach follows the *learning by doing* paradigm (Kolb, 1984): young professionals can "play" with the T-Matrix in order to solve assigned compound design problems and check the adequacy of their solutions against the required performances on the basis of criteria that make sense in the CoP they are going to belong to. The possibility to access and put at work the value of the experiential knowledge incorporated in the T-Matrix knowledge artifact contributes to reduce the time newcomers need to become a legitimate participant. On the one hand, they can acquire the jargon used by the community in the context of the concept model it generated. On the other hand, they immediately become active since the T-Matrix objectifies the mechanisms governing the innovation process characterizing this community.

From the more general innovation management point of view, we are planning to monitor the results of the adoption of the proposed KM technology by observing its use within the P-truck project. Moreover, we will develop the basic concept of knowledge artifact and better understand its role in the identification of the boundaries of a CoP as a general approach to the design of KM applications supporting innovation processes and an effective innovation management.

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Supporting an Experiment of a Community Support System: Community Analysis and Maintenance Functions in the Public Opinion Channel

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Abstract. Community analysis and maintenance functions of a community support system called Public Opinion Channel (POC) are described. A field-test and a psychological experiment using a community support system are important for investigating activities in a community. Existing community support systems, however, have limitations on having an experiment smoothly because few systems consider functions for supporting an experiment. To investigate activities in a community smoothly, community support systems should have community analysis and maintenance functions that support an analyst and a community organizer in an experiment. We implemented those functions in the POC system, and used in a field-test and a social psychological experiment. From these experiments, we found that proposed functions enabled an analyst and a community organizer to (1) find up-to-date state of a community during an experiment, (2) analyze relations between messages efficiently and objectively, and (3) maintain communities easily. Requirements for the functions, implementation, and experience in the experiments are described.

M. Huysman et al. (eds.), Communities and Technologies, 347-367.

Introduction

The Internet enabled us to find information and people easily. We can find people who have similar interests or goals, and form or join a network community. A network community has possibilities for creating artifacts, sharing knowledge, and solving problems more effectively than traditional organizations such as companies and universities. Linux and free software communities are good examples of successful network communities. We consider that fine interactions, which enable community members to create and share knowledge effectively, exist in those successful communities. We call those communities *knowledge-creating (KC) communities.*

Besides KC communities, there are *sick communities* where too few or too much information is exchanged. There occurs a *flaming*, which is an endless quarrel between community members, frequently in a sick community. In another community, the deflation of communication called *spiral of silence* hinders exchange of opinions (Noelle-Neumann, 1984). There are few fine interactions in sick communities

Our concerns are factors that form and sustain a KC community. What are differences between KC and sick communities? How can we form a KC community? What kind of interaction sustains a KC community? Although we don't have clear answers for these questions, we are tackling them by creating and evaluating a community support system called PUBLIC OPINION CHANNEL (POC) (Fukuhara et al., 2003).

Through development and experiments of the POC system, we found the importance of an experiment stage in the development cycle of a community support system. We can acquire valuable data in an experiment. Based on acquired data, we can improve the system and have a next experiment. Meanwhile, having an experiment is not easy because maintaining communities and analyzing data are burdens for researchers. Functions for supporting researchers to have an experiment smoothly are needed for investigate a KC community efficiently.

In this paper, we propose community analysis and maintenance functions of a community support system. We implemented those functions in the POC system. Through a field-test and a social psychological experiment using the POC system, we found feasibilities of the proposed functions for having an experiment smoothly.

This paper is organized as follows. First, we analyze the development cycle of a community support system, and describe requirements for community analysis and maintenance functions (Section 2). We will then describe an overview of the implemented functions in the POC system (Section 3). Next, we will describe our experience in a field-test and a social psychological experiment using the POC system (Section 4). We will compare our proposal with relevant works (Section 5). We summarize arguments, and describe the future work (Section 6).

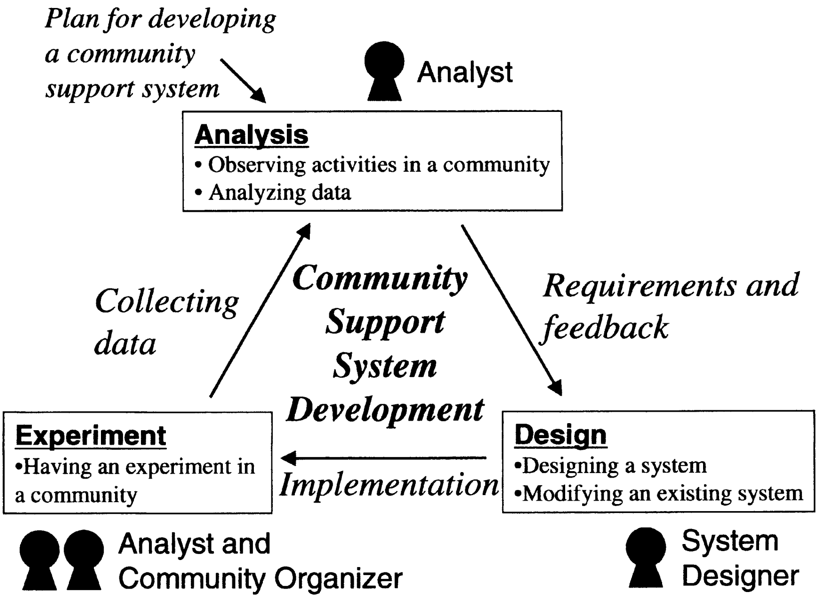

Figure 1: Development cycle of a community support system.

Community analysis and maintenance functions in a community support system

In this section, we describe requirements for community analysis and maintenance functions by analyzing the development cycle of a community support system.

Development cycle of a community support system

To investigate a KC community, repeating a cycle that consists of implementation and evaluation of a community support system smoothly is important. Figure 1 shows the development cycle of a community support system.

The cycle consists of (1) *analysis*, (2) *design*, and (3) *experiment* stages.

(1) *Analysis stage*. In this stage, an analyst observes activities in a community, and specifies requirements for supporting those activities. S/he tells the requirements to a system designer for designing a system.

(2) *Design stage*. The system designer designs and implements a prototype system according to the requirements. The system is improved in case of an existing system. The system is tested in the experiment stage.

(3) *Experiment stage*. The analyst cooperates with a community organizer to have an experiment. During an experiment, the analyst observes activities of community members, and records data such as utterances and

operations of members. The organizer supports the analyst by doing miscellaneous works such as creating new communities, configuring settings of them, adds or removes accounts of community members, and removes unnecessary messages and communities. The analyst analyzes data, and gives feedback to the designer for improving the system.

Repeating this cycle smoothly is important for both of development of the system, and investigation into a KC community.

Problems in an experiment of a community support system

Having an experiment is not easy because analyzing data and maintaining communities are burdens for an analyst and a community organizer. In a long-term field-test that is held for several months, a large volume of data is acquired. To find important facts from those data is not easy for an analyst (Nishida et al., 1998; Bruckman et al., 2001). Furthermore, it is difficult for an analyst to follow the latest state of a community during a field-test because s/he is busy observing activities and recording data. Furthermore, s/he might also have to maintain communities.

From the viewpoint of a community organizer, s/he has to engage in miscellaneous works during a field-test. An organizer has to prepare communities before a field-test. S/he also has to prepare community members' accounts (for account-based systems). During a field-test, an organizer has to check messages posted by members. In case of inappropriate messages, an organizer has to remove them. Without an easy interface for configuring settings of a community, an organizer has to edit configuration files of the system manually. To edit configuration files, an organizer has to have much knowledge on the system such as internal structure for changing settings of a community. It is not practical for an organizer to have such miscellaneous knowledge because s/he is not a designer.

Community analysis and maintenance functions are needed for having an experiment smoothly. Previous works on field-tests of community support systems (Nishibe et al., 1998; Matsuda et al., 2002), however, do not mention those functions. Although frameworks of a community support system are proposed (Koch and Lacher, 2000; Yoshida et al., 2000), their focuses are not on community analysis and maintenance works. The lack of community analysis and maintenance functions hinders system development and investigation into KC communities.

Community support systems should have community analysis and maintenance functions. Those functions should facilitate (1) an analyst to collect and analyze data, and (2) a community organizer to configure settings of a community. We describe requirements for these functions in the following subsections.

Requirements for a community analysis function

Followings are requirements for a community analysis function.

Logging and analyzing server logs

Logging and analyzing *server logs* that are stored in a server application are needed. In case of a server-client system, actions taken by a client application can be identified by the server. Recording and analyzing server logs are important for understanding activities of community members.

Server logs should be analyzed automatically because too many logs to analyze manually are collected in an experiment. A community analysis function should provide basic statistic data that indicate an overview of activities for an analyst.

Storing and analyzing messages

A community analysis function should store and analyze *messages* that are information exchanged between community members. Analyzing messages, especially relations between them, is important for finding key messages that activated or hindered discussions in a community. Because there are implicit relations between messages that cannot be identified by reference structures, the function should analyze both of implicit and explicit relations.

Requirements for a community maintenance function

Followings are requirements for a community maintenance function.

Maintaining settings of a community

The function should allow a community organizer to maintain a community. During an experiment, there often occur needs for changing settings of communities such as adding another accounts to a community. The function should not require an organizer for having much knowledge on the system. An easy interface is needed because an organizer might not be a computer expert.

Maintaining accounts of community members

The function should allow an organizer to maintain accounts of community members. In an experiment, there occur needs for adding accounts to a community, changing properties of accounts, and remove unnecessary accounts from the community. The function should enable an organizer to engage in those works.

Maintaining messages

The function should enable an organizer and an analyst to check and maintain messages. In case of a field-test that is held in an open environment such as the Internet, there might be spam messages that disturb ordinary discussions. The function should allow organizer and analyst to check contents of messages, and remove spam messages.

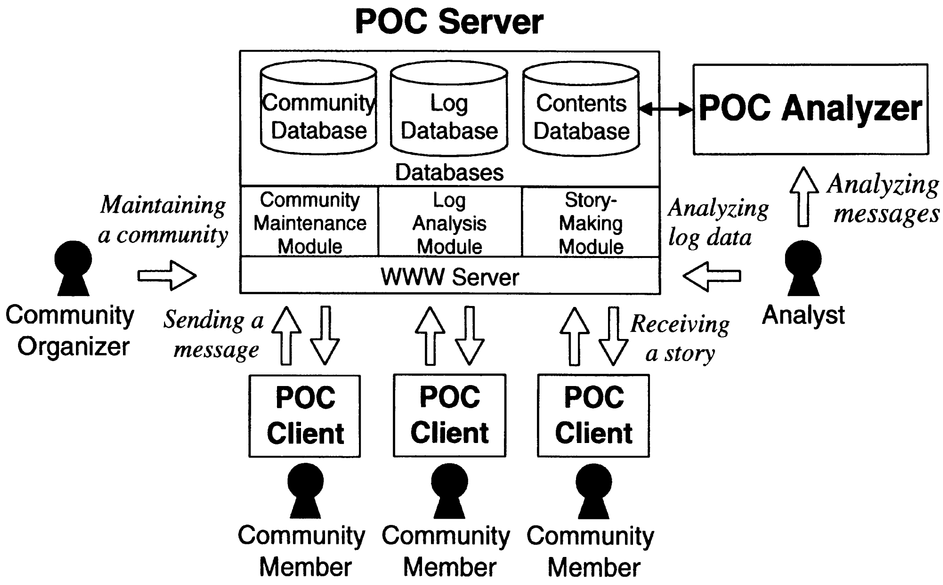

Figure 2: Architecture of the POC system

Community analysis and maintenance functions in the POC system

We implemented the requirements for community analysis and maintenance functions in the POC system. We describe architecture of the system, and implemented functions.

Architecture of the POC system

Figure 2 shows the architecture of the POC system. The system consists of (1) *POC server*, (2) *POC clients*, and (3) POC ANALYZER.

(1) *POC server*. POC server is the main part of the POC system. The server provides basic services for POC clients, and community maintenance and analysis functions for a community organizer and an analyst. The server consists of (a) *log analysis module*, (b) *community maintenance module*, and (c) *story-making module*.

a) *Log analysis module*. This module analyzes server logs stored in the log database. The module generates *reports* that contain graphs and basic statistic data on a community and its members. The server records specific actions of POC clients in the log database. An example of a server log and a list of actions are described in Section 3.2.1.

Figure 3: Message and story

b) *Community maintenance module*. This module allows a community organizer to configuring settings of a community. The module also manages messages and stories of the POC system (see Figure 3). A message consists of meta-information (in the opinion tag), title, body (in the comment tag), and URL. A story consists of several messages.

c) *Story-making module*. This module creates a story automatically based on relevant messages (Kamada et al., 2002).

(2) *POC clients*. The clients are tools for community members. There are several clients. POC COMMUNICATOR is a client for sending a message to the POC server (Fukuhara et al., 2002). POCTV is a client for watching stories in a talk show style (Kubota and Nishida, 2001).

(3) POC ANALYZER. This is a tool for analyzing relations between messages. It accesses to the contents database of the POC server, and analyzes messages in the database. Relations between messages are represented as a network. POC ANALYZER shows the network graphically.

Community analysis function

As community analysis functions, we describe (1) the log analysis module and (2) POC ANALYZER.

Line	Event
1	TRY LOGIN account=person1 community=kc_talk [2002-07-10 19:09:55]
2	ACK LOGIN account=person1 community=kc_talk [2002-07-10 19:09:56]
3	LIST COMMUNITIES IP=xx.xxx.xx.xx account=person1 clientName=COMMUNICATOR [2002-07-10 19:09:58]
4	LIST MESSAGES client=COMMUNICATOR account=person1 [2002-07-10 19:10:00]
5	SEARCH MESSAGE query='wind' clientName=COMMUNICATOR account=person1 community=kc_talk found=47 [2002-07-10 19:16:20]
6	ACK MESSAGE IP=xx.xxx.xx.xx file=bbs107.xml account=person1 community=kc_talk [2002-07-10 19:23:31]
7	LOGOUT community=kc_talk IP=xx.xxx.xx.xx account=person1 [2002-07-10 19:48:43]

Table 1: Example of a server log

Token	Description
ACK LOGIN	A client succeeded in logging in.
NACK LOGIN	A client failed to log in.
LIST COMMUNITIES	A client requested a community list.
LIST MESSAGES	A client requested a message list.
LIST STORIES	A client requested a story list.
SEARCH MESSAGES	A client retrieved messages.
SEARCH STORIES	A client retrieved stories.
ACK MESSAGE	A client posted a message.
ACK STORY	A client posted a story.
LOGOUT	A client exited from a community.

Table 2: List of tokens

The log analysis module and POC ANALYZER are components of the *SIQ (Social Intelligence Quantity) package* that is a set of metrics for evaluating communication tools (Yamashita and Nishida, 2002). The log analysis module and POC ANALYZER are tools for analyzing quantitative data in the SIQ package.

Log analysis module in the POC server

The log analysis module supports an analyst to analyze server logs. Table 1 shows an example of a server log that indicates a series of actions taken by an account called 'person1'. A log consists of several *events*. An event indicates specific actions taken by a POC client. In Table 1, each line represents an event. For example, line 6 indicates that 'person1' posted a message whose filename is 'bbs107.xml' to the 'kc_talk' community.

Event type can be identified by *token*. Table 2 shows a list of tokens. An event consists of token, IP, date, and optional parameters such as account, and client name.

The log analysis module consists of several CGI scripts (written in Perl) that run on a WWW server. An analyst can analyze log on a Web browser. S/he can browse various reports exploratory by changing parameters such as a period of time, community name, and account.

There are following reports in the POC server.

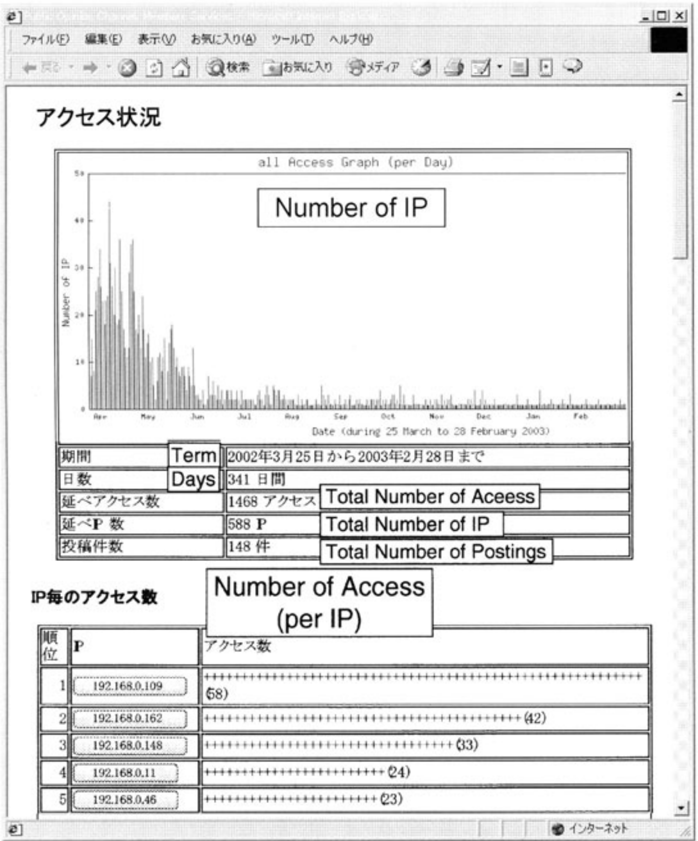

Figure 4: Report on number of access.

(1) *Number of access.* This report provides a summary of access to the POC system (see Figure 4). The figure shows total number of access / IP / postings in a specified term. The figure also shows number of access per IP as a ranking list. By clicking a button in the list, an analyst can browse a *browsing behavior report* (described later) for each IP.

(2) *Postings per community.* This report analyzes number of postings per community (see Figure 5). The figure shows cumulative number of postings, and total number of postings per community.

(3) *Posting behavior.* This report analyzes posting actions for each account (see Figure 6). The figure shows posting actions taken by an account ‘q5c552’. This report shows number of postings per day, daily trend of postings, and a list of messages and stories posted by this account.

(4) *Browsing behavior.* This report analyzes browsing actions of each account. The report shows number of messages and stories browsed by an account.

(5) *Contents ranking.* This report shows frequently accessed contents.

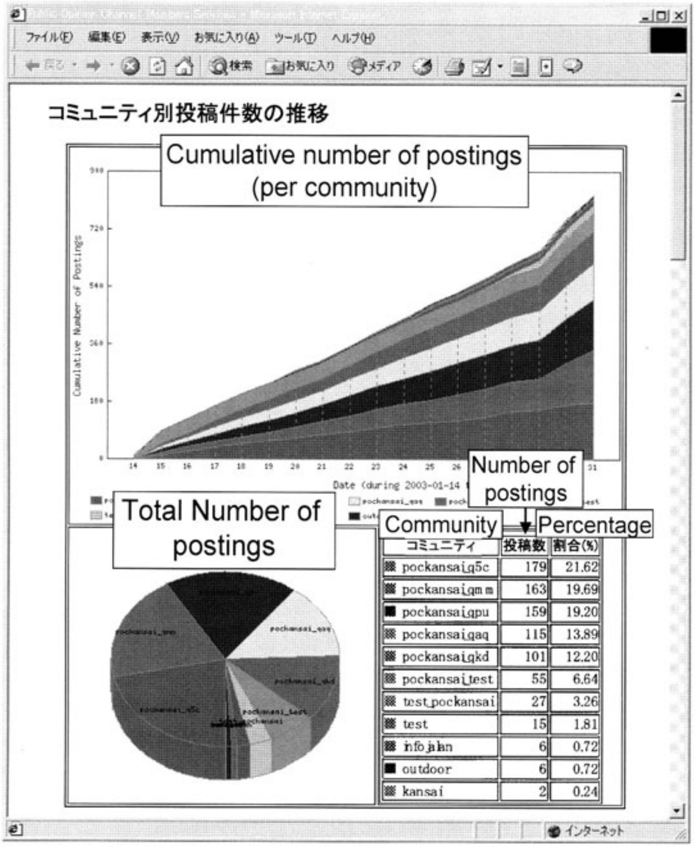

Figure 5: Report on postings per community.

(6) *Session.* This report analyzes duration of each session per an account. A session can be identified by ‘ACK LOGIN’ and ‘LOGOUT’ tokens.

(7) *Recent postings.* This report analyzes messages and stories posted in the last three days. One can browse contents of messages and stories.

POC ANALYZER

POC ANALYZER is a tool for analyzing relations between messages. This tool is written in C, and runs as a Linux application. Figure 7 shows a screen image of POC ANALYZER. Relations between messages are represented as a *network* where messages are represented as *nodes* and relations are represented as *directed links*. POC ANALYZER shows a network graphically. By looking at a network graph, an analyst can find key messages in the network.

POC ANALYZER consists of (1) *parameter field*, (2) *list field*, (3) *graph field*, and (4) *information field*.

Figure 6: Report on posting behavior.

(1) *Parameter field.* In this field, an analyst can create networks by specifying parameters. S/he can specify similarity threshold between messages, and keyword and its feature value in the option tab. S/he can also specify the period of time in the term tab.

(2) *List field.* This filed shows a list of networks that meet specified parameters in the parameter field. An analyst can select a network

according to feature values of a network. Feature values include number of nodes, maximum number of *indegree* and *outdegree* that indicate number of incoming and outgoing links of a node (Wasserman and Faust, 1994, p.126), and maximum number of *mean path length* (*mpl*) / *centrality / density* (meanings of these values are described later).

(3) *Graph field.* This field displays a graph of the selected network in the list field. A popup window, which shows an overview of a node, appears when a mouse cursor is over the node.

(4) *Information field.* This field shows (a) information on the selected node in the graph field (such as author and date), and (b) information on the selected network in the list field (such as number of nodes/links).

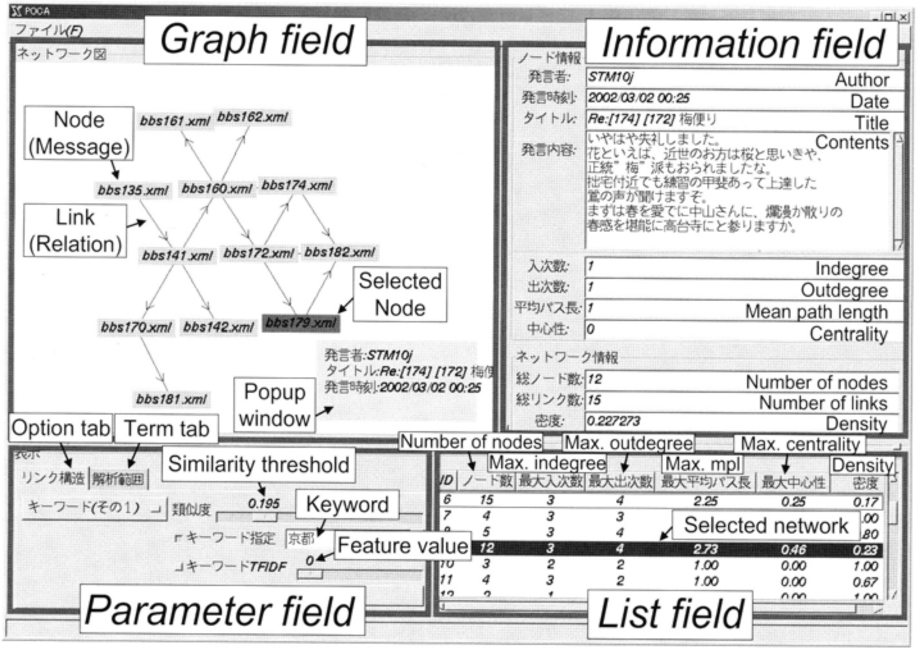

Figure 7: POC ANALYZER.

POC ANALYZER analyzes relations according to the following steps.

(1) Create a network by finding links between two messages.

  (a) Make a link when either one has a reference to the other.

  (b) Make a link when similarity is larger than threshold τ.

(2) Calculate feature values for the network.

Firstly, POC ANALYZER creates a network according to the reference structure and similarity among messages. In case of the reference structure, a link is created between messages. A link begins from a message that has a reference attribute, and

ends with the referred message. In case of similarity, POC ANALYZER calculates similarity between two messages based on the vector space model (Salton, 1989).

In the vector space model, a message is represented as a vector. A vector consists of feature values for terms that appeared in the message. A feature value (w_{ij}) for the j-th term ($term_{ij}$) of the i-th message ($\boldsymbol{D}_i$) is calculated by

$$w_{ij} = tf_{ij} \cdot \log(\frac{N}{df_j}),$$

where tf_{ij} is the word frequency of $term_{ij}$ in $\boldsymbol{D}_i$, N is the total number of terms, and df_j is the number of messages that contain $term_{ij}$.

$\boldsymbol{D}_i$ is a vector that consists of feature values (w_{ij}) for each term in the message.

$$\boldsymbol{D}_i = (w_{i1}, w_{i2}, \ldots, w_{iN})$$

Similarity between messages p and q ($sim(\boldsymbol{D}_p, \boldsymbol{D}_q)$) is calculated by the following formula.

$$sim(\boldsymbol{D}_p, \boldsymbol{D}_q) = \frac{\sum_{i=1}^{N} w_{pi} \cdot w_{qi}}{\sqrt{\sum_{i=1}^{N} w_{pi}^2} \cdot \sqrt{\sum_{i=1}^{N} w_{qi}^2}}$$

The direction of a link is from an old message to the new one.

After creating a network, POC ANALYZER calculates feature values of the social network analysis. POC ANALYZER calculates (1) *density*, (2) *centrality* (we use *betweenness centrality*), (3) *mean path length*.

Density (D) of a network is a feature value that represents the quantity of links in the network (Wasserman and Faust, 1994, pp.101-102). D is calculated by

$$D = \frac{l}{L_{\max}},$$

where l is the actual number of links in the network, and L_{max} is the maximum number of possible links for the network, i.e., a node has links with any other nodes in the network. A network that has high density value can be regarded as a homogeneous network that contain same or similar topics.

Betweenness centrality of a node N_i ($Cb(\mathrm{N_i})$) is a feature value that represents the influence of a node N_i in a network (Wasserman and Faust, 1994, pp.188-191). $Cb(\mathrm{N_i})$ is calculated by

$$Cb(N_i) = \frac{L_{jk}(N_i)}{L_{jk}},$$

where $L_{jk}(N_i)$ is the number of *geodesics* between any nodes N_j and N_k that pass through N_i. A geodesic is the shortest sequence of links between two nodes (Wasserman and Faust, 1994, p.110). There might be several geodesics between two nodes. L_{jk} is the total number of geodesics between N_j and N_k. A node that has

high betweenness centrality value can be regarded as a node that summarized previous topics, and stimulated community members to post further messages.

Mean path length of a node N_i ($mpl(N_i)$) is the average of path length between nodes N_i and its descendant nodes that can be found by following outgoing links. POC ANALYZER calculates $mpl(N_i)$ as

$$mpl(N_i) = \frac{\sum_{j \in Desc(N_i)} g(N_i, N_j)}{count(Desc(N_i))},$$

where $Desc(N_i)$ is a set of descendant nodes of N_i, $count(Desc(N_i))$ is the number of nodes in $Desc(N_i)$, and $g(N_i, N_j)$ is the *geodesic distance* between N_i and N_j. N_j is a descendant node of N_i. A geodesic distance is the length of a geodesic (Wasserman and Faust, 1994, p.110). A node that has high mean path length value can be regarded as a message whose topic affects many messages in a community.

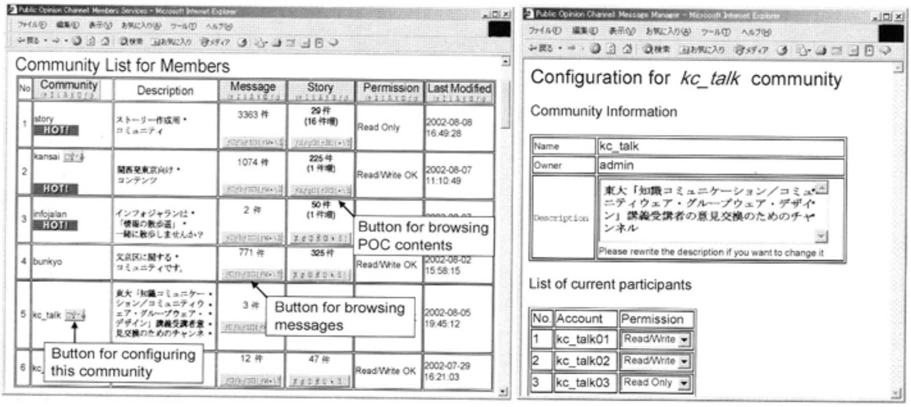

Figure 8: Web pages for browsing and configuring settings of communities.

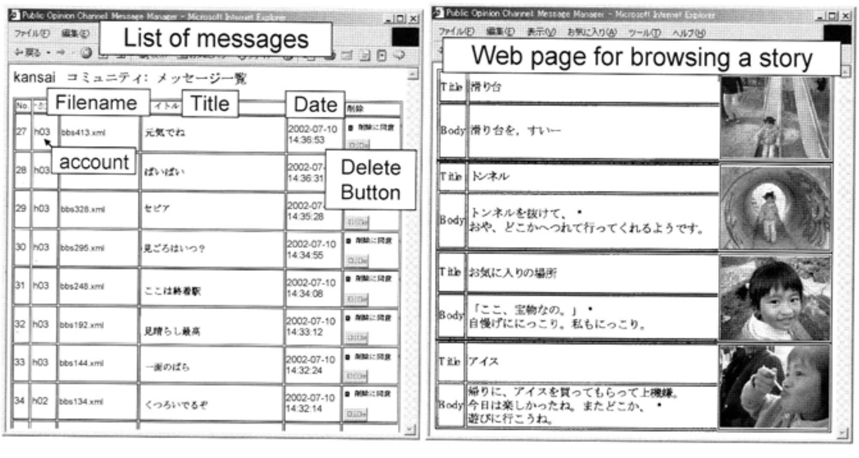

Figure 9: Web pages for browsing messages and stories.

Community maintenance function

The community maintenance module provides Web pages for browsing and configuring settings of a community. A community organizer can create a community, add accounts for newcomers of a community, and change permissions of accounts. Figure 8 shows web pages for browsing and configuring settings of communities. An organizer can find number of messages and stories posted in a community, and s/he can configure settings of a community. Figure 9 shows Web pages for browsing messages and stories. An organizer and an analyst can check contents of a message and a story. S/he can also remove unnecessary messages and stories.

Figure 10: Technical staff of the helpdesk.

Evaluation

We describe experience in a long-term field-test called KDDI FTTH trial, and a social psychological experiment using the POC system.

KDDI FTTH trial

We had a field-test of the POC system in the KDDI FTTH (Fiber to the Home) trial. The trial was held for one year (from March 25 in 2002 to February 28 in 2003). 443 households in Shinjuku and Bunkyo areas in Tokyo participated in the trial for evaluating broadband services such as VOD (Video on Demand) and videoconference. We provided the POC system as one of services.

Our aim in this field-test was to find tacit knowledge on Shinjuku and Bunkyo areas, and circulate the knowledge among participants. Therefore, we hosted communities that treat topics on local information on Shinjuku and Bunkyo areas.

For supporting participants and observing activities of them, we set up (1) a *helpdesk*, and (2) an *analysis team*. The helpdesk, which consists of one technical staff (see Figure 10), played the role of a community organizer (see Figure 1). Her tasks include (a) answering questions from participants, (b) checking contents of postings, and (c) maintaining postings and communities.

The analysis team, which consists of a cognitive psychologist and a social psychologist, played the role of an analyst (see Figure 1). The team estimated system usage by analyzing server logs. They provided feedback for the system designers for improving the system.

We found following merits of the proposed functions.

(1) Understanding current state of communities.
(2) Analyzing server logs instantly.
(3) Maintaining communities easily.

Understanding current state of communities

The log analysis module enabled the analysis team to find current state of communities. Figure 11 shows number of access to the log analysis module. Total number of access was 2,258. Most of access was made by the number of access report that shows the latest access to the system (see Figure 4). During the trial, the team was able to follow up-to-date state of communities objectively by browsing this report. The team checked this report frequently by reloading its Web pages regularly (e.g., in the morning, after having a lunch, and before leaving the office).

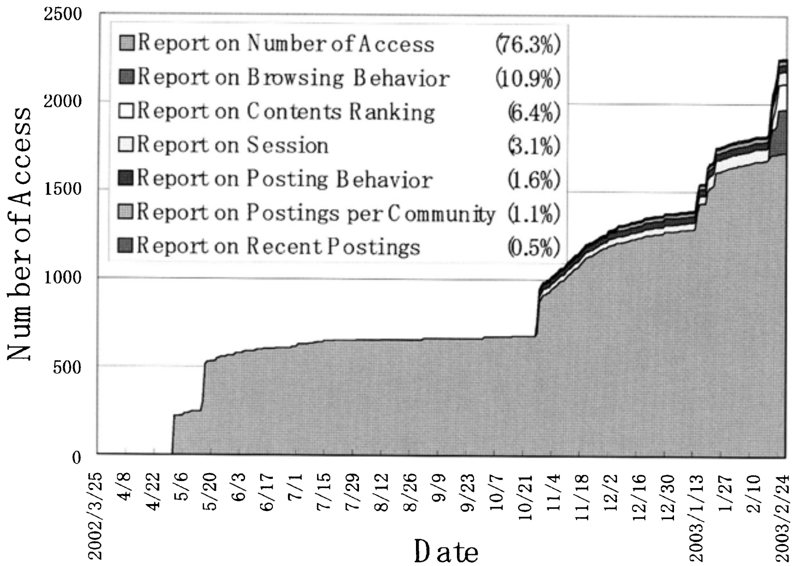

Figure 11: Usage of the log analysis module in the FTTH trial.

Analyzing server logs instantly

The log analysis module enabled the analysis team to analyze server logs instantly. The module had not been implemented until early May (see Figure 11). It was hard for the team to analyze server logs manually. They had to write scripts for parsing and extracting data from logs. It took much time to analyze data. Although they were able to reuse the scripts, it was inconvenient to log in the POC server, and runs scripts on a UNIX terminal.

By using the log analysis module, the team was able to analyze server logs easily. Although we acquired 9.8MByte (118,713 events) of server logs in the trial, the module was able to analyze them around 10 seconds (tested under a server machine that has Pentium III 800MHz dual processors and 1GB memory). The time required for analyzing logs was not a serious issue during the trial. The log analysis module was extended in the latter term of the trial (around November 4 in Figure 11) according to the suggestions of the analysis team.

Maintaining communities easily

The technical staff was able to maintain communities easily. Before the community maintenance module was implemented, the staff had to ask a system designer to configure settings of communities. It was inconvenient for both of staff and the designer. After implementing the module, she was able to configure settings of communities, and maintain messages and stories by herself. She was able to engage in her works on her Web browser easily.

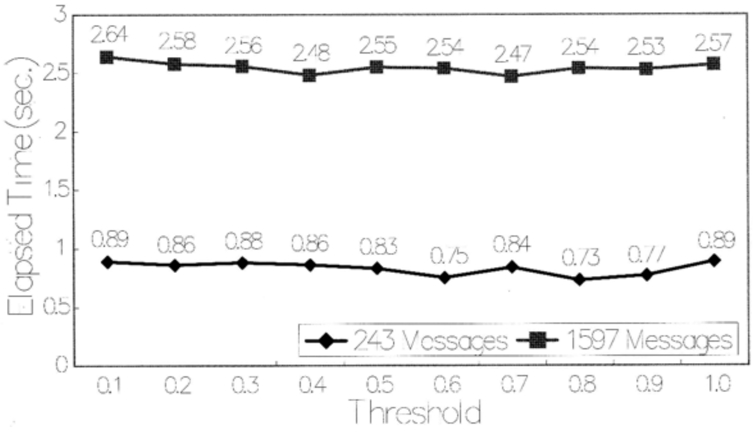

Figure 12: The time required for analyzing messages.

Social psychological experiment

We had a social psychological experiment using the POC system (Matsumura et al., 2002). In this experiment, 20 subjects were asked to exchange messages using the

system with other subjects for four weeks. 243 messages were exchanged in this experiment. We found followings merits of the proposed functions.

(1) Analyzing messages efficiently and objectively.
(2) Understanding activities in a community totally.

Analyzing messages efficiently and objectively

POC ANALYZER enabled a psychologist to analyze relations between messages efficiently and objectively. Figure 12 shows the time required for analyzing messages. The average time for analyzing 243 messages was 0.83 seconds (tested under a workstation that has Xeon 2.4GHz single processor and 512MB memory). For comparison, we also measured time using another set of messages that contain 1,597 messages. The average was 2.55 seconds for 1,597 messages. A psychologist was able to analyze messages efficiently. Furthermore, because POC ANALYZER analyzes messages based on objective criteria, several psychologists were able to share and discuss the same analysis results.

Understanding activities in a community totally

The combination of results from log analysis module and POC ANALYZER was useful for analyzing activities in a community totally. By using the log analysis module, the psychologist was able to check recent activities in a community. Once he found interesting activities, he analyzed messages by using POC ANALYZER. By combining results from both tools, the psychologist was able to analyze activities in a community by complementing each result.

Related work

Hilbert proposed an environment for testing usability of software (Hilbert and Redmiles, 1998). This environment monitors and collects user interface (UI) events remotely. This approach is suitable for understanding microscopic activities of the user of software. Meanwhile, it is not suitable for understanding macroscopic activities of the user such as results in the log analysis module.

With respect to a communication tool that has an analysis function, there are CollabLogger and LumberJack (Morse and Steves, 2000; Chi et al., 2002). Focuses of these tools are on the log analysis. Meanwhile, our focus is on total support of an experiment. We focus on not only the log analysis, but also message analysis and community maintenance. Implemented functions supported community maintenance and analysis works.

With respect to the message analysis, several message analysis tools are proposed (Sack, 2000; Smith and Fiore, 2001). With respect to the log analysis tools, there are tools for analyzing server logs such as Analog (www.analog.cx), Report Magic (www.reportmagic.org), and Lire (www.logreport.org/lire/). If we

look at either POC ANALYZER or log analysis module only, we hardly find differences between those tools and implemented functions. An important point, however, is that the combined use of analysis tools is important for analyzing activities in a community totally. In the social psychological experiment, the psychologist was able to analyze activities in a community by using both of analysis tools.

Summary and future work

We described community analysis and maintenance functions in the POC system. Having an experiment of a community support system smoothly is important for investigating a KC community. We proposed requirements for community analysis and maintenance functions, and implemented those requirements in the POC system. We tested implemented functions in the FTTH trial and a psychological experiment. The implemented functions supported community maintenance and analysis works in those experiments.

Our proposal is a basic support for an analyst and a community organizer during an experiment of a community support system. We believe that our proposal is one of first steps for investigating a KC community. Our future work is to continue to have experiments using the POC system, and gain feedback from analysts and community organizers.

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Patients' Online Communities Experiences of emergent Swedish self-help on the Internet

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Abstract. This paper identifies and analyses characteristics of Patients' Online Communities (POC) in Sweden. The purpose of the paper is to increase our understanding of how individuals design online social support and how this can inform design in a wider perspective. The study presents a fine-grained picture of POC covering both the contextual structures and the community culture. Two important driving forces of POC (to get informed and to interact with others in similar situation) are identified. These serve as a basis for the introductory discussion provided on how the experiences from POC can serve as implications for the emergent design of Internet based communication between patients and health care providers.

Introduction

Today many people are involved in various online communities such as web chats (Sveningsson, 2001) newsgroups (Baym, 1995; 1998) or MUDs (Multi User Dungeon) (Reid, 1999). These are examples of how the computer network technology "*allow for people to create a range of new social spaces in which to meet and interact with one another*" (Kollock & Smith, 1999, pp. 3). Roughly these can be categorised as online communities of special interests in which people participate because they share a common interest. However, the focus in this paper is on a specific kind of online self-help community where people are brought together more by coincidence and by reasons beyond their control. This

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article identifies and analyses characteristics of **P**atients' **O**nline **C**ommunities (POC)[1] in Sweden. These online communities might even be categorized as "communities of *unintended* interest" referring to the (sometimes dramatically) changed life situation not controlled by the individual. This means that if the patients did not suffer from the disease they would probably not have taken an interest in it.

Lately patients' on-line self-help has attracted an increased research interest. Studies in the field have concerned the benefit for patients to participate (Ferguson, 2000) as well as the self-help processes taking place (Finn, 1999) in the groups. Additional studies have focused the quality of the medical information (Ferguson, 2002) while others discuss the transformation of patients as users into producers of medical information (Hardey, 2001) due to their online participation.

Although the increased research interest little attention has been paid to capture the structural and cultural outline of POC. Consequently, the main purpose of the paper is to increase our understanding of how individuals design social online support for difficult life situations.

Additionally, few scholars have focused how an increased knowledge of this unique type of online communities can inform the design of emergent health care resources on the Internet. Although the Internet is a powerful instrument for enabling interaction between people and organizations (Kahn, 2000) it is still under used (Rice & Katz, 2001) when it comes to the relationship between patients and healthcare. Several studies emphasise the need to use the Internet more effectively in this area (Sittig et al, 2001; Eysenbach & Diepgen, 1999; Ball & Lillis, 2001).

In order to meet the specific needs of patients' their participation in the development of online health care resources is important (Leimeister et al, 2002). Consequently it is here argued that the design of POC and patients' use of the Internet for medical information in general (Josefsson, 2002) is a valuable source for design implications. Therefore, an additional purpose of the paper is to introduce a discussion about how the experiences of POC can serve as implications for design of Internet based communication between patients and health care providers.

In order to accomplish this Nancy Baym's (1995, 1998) model of '*the emergence of on-line community*' is applied. This model takes a constructivist perspective and emphasizes the emergence of an online community as a complex interplay between the participants, the context and the technology. Applying the model for explorative purposes it brings the opportunity to identify both the structures of POC and the cultural dynamics as well as to get an understanding of the complex interplay between these two.

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[1] Although notions like "self-help groups" or "social support groups" sometimes are used the term Patients' Online Communities (POC) is preferred in this paper since it more directly make visible the kind of online support group focused.

By applying the model to examine this special kind of online phenomenon designed by individuals the paper contributes to an increased understanding of the functions of online communities and how they support certain practices (Mynatt et al, 1999). More specifically, the paper contributes with a fine-grained picture of the structural and cultural context of a kind of online communities created because of difficult changes in private life situations.

As the use of the Internet in everyday life develops there is a need to learn more about these online activities, their effects and the role of this technology use in peoples lives – offline as well as online (Haythornthwaite & Wellman, 2002). The presented study of POC also contributes as a good example to this growing body of research.

Further, the choice to examine Swedish POC is believed as an important arena for these studies since Sweden and also other Scandinavian countries have a broad access to the Internet at workplaces as well as in private households and public spaces (Sweden Statistics, 2001) although the countries to not have the tradition of self-help as in the Anglo-American countries (Kummervold et al, 2002).

The paper is structured as follows. First, the performed research study is outlined followed by a presentation of Nancy Bayms' model of "The emergence of on-line community". The model is then applied in order to identify and analyse the characteristics of the participating patients online communities. Finally, there is a discussion about distinctive features of POC and their significance for design.

The research study

This paper is based on data from three related research studies performed during 2001 and 2002 (Table 1).

Method	POC/interviewees /answers	Question areas
Observations	15 POC	Structural design/ performed practices/ what the POC offer visitors or members in terms of interaction and information.
Questionnaire	4 POC (2 e-mail lists and 2 open discussion boards)	Patterns of use of the Internet for medical information/ pros and cons/ effects on relationship - health care provider and
(Open questions)	39 answers	professionals/ ideas of future use of Internet for patients/health care.
Semi-structured interviews	10 interviews with imitators of 10 POC	Why and how the POC was started/ how the POC has developed/ technical and social structure/pros and cons/ future of the POC.

Table 1: Summary of the performed research studies

The first study involved *observations* of Swedish POC on the Internet. The idea was to examine online communities initiated and managed by individuals addressing a special disease or patient group and providing interactive facilities. By the use of Internet search engines like "Altavista", "Google" and "Yahoo" 15 POC was selected representing diseases such as multiple sclerosis, thyroid problems, fibromyalgia, and whiplash. The time these POC have been online varies between two to seven years. The observations resulted in an initial understanding of the structures of the online phenomenon and the performed practices.

The second study consisted of a minor *questionnaire* in four POC with the purpose to highlight patients' experiences and expectations of the use of the Internet for medical information and to emphasize their ideas of Internet use in the relationship with healthcare. Two discussion boards and two e-mail lists comprise the four patient online communities in the study. The questions asked were open and concerned areas of patterns of use and what the patients appreciate most about the online community and the Internet use for medical information and what they believe can be improved and further developed.

Even if the original purpose involved an expectation for a larger number of answers, a total of 39 answers were received. The total answer rate can only be estimated approximately since two of the participating communities were open to all visitors of the web pages. The other two communities (the e-mail lists) had a total of 205 members at the time of the questionnaire. Although the questionnaire was limited in several respects the participating patients presented a rich picture of their experiences of various online medical resources. This has served as an important introduction to the area and for future research.

The third study involved ten semi-structured *interviews* with the initiators[2] of ten of the previously observed POC. Seven of the interviewees were women and three were men and the ages varied between 25 and 65. The interviews involved only a few specified question areas involving issues on how and why the communities were initiated and how they have developed since the start. The questions also concerned social and technological issues of online communities as well as future oriented questions. Additionally thoughts on reactions from healthcare on the on-line community activities were treated. Each interview lasted for about 45 to 70 minutes and were tape-recorded and transcribed.

The Emergence of On-Line Community

Drawing on the work by e.g. Contractor & Siebold (1993), Hollingshead & McGrath (1995) and Siebold et al (1994) Nancy Baym (1995, 1998) have

[2] Throughout the paper the term "initiator" is used synonymous with the term "owner" both indicating a person who has created and are also managing a POC.

suggested a model originally designed in an attempt to answer the question of "*what occurs online that leads some people to experience them (online communities) as communities in the first place?*"

In the research field of CMC a technology deterministic tradition has been dominating (Baym, 1995). As a contrast the model focus the research work aiming at an understanding of the complex interplay between both human activities and the technology. As thus, the aim of the model is to capture the process in which an online community and its participants create a community culture and a sense of community.

The underlying idea of the model is that different cultures emerge in online communities and that these cultures are grounded in communicative practice. This practice can be described as interplay between the pre-existing structures of the community and the participants' appropriation and use of the resources and rules offered by the structures.

In addition, the model offers the identification of important components as well as an understanding of the social activities of online communities. Therefore, as in this article, the model can also be used to analyse special kind of communities in order to increase our knowledge of them as emergent online phenomena.

Supported by the above CMC research work Baym (1995; 1998) start by identifying five pre-existing structures of online communities; *external context, temporal structure, system infrastructure, group purpose* and *participant characteristics*. In the following each of these will be presented[3].

- *External context*: reflects the online environment in which the communication is situated like the technical and social practices along with the group relevant resources brought in to the online community by its participants. This also concerns the location of the immediate access to the technology.
- *Temporal structure*: involve the possibility to communicate synchronous or asynchronous influencing the number of participants as well as the access to immediate feedback and the possibility to write and rewrite messages. Also this concerns the maintenance of archives that bring the opportunity to visit past discussions.
- *System infrastructure*: concerns the configuration and flexibility of the technology in addition with user friendliness.
- *Group purposes*: refers both to purposes basic for the existence of the community and also the purposes that emerge through interplay between the participants.
- *Participant characteristics*: relate to different experiences and knowledge of the community theme along with diversity of social and geographical

[3] For a comprehensive reading of the model, see Baym (1995; 1998)

residence of the participants. Additional characteristics concern the size of the group and different experiences of information technology use along with differences in age, sex and education.

The five pre-existing structures are closely intertwined and related to each other. Together they set a complex basis for the study of important components in order to understand the emergence of an online community. However, these structures are not enough since also the social dynamics of a group need to be considered. According to Baym (1995; 1998) these are the result of the participants' appropriation and use of the resources and rules offered by the pre-existing structures. Drawing on research work on CMC[4] four categories of social dynamics are suggested and discussed. These categories are forms of expression, identity, relationship and behavioural norms. In the following each one of these is briefly addressed.

- Forms of expression: is related to the development of "group specific vocabulary", "unique forms of jokes" and also social cues like the use of nonverbal information such as smileys.
- Identity: concerns how a name is created or how participants get "famous" in the group. The identity creation also concerns how anonymity and made up identities are treated in the community.
- Relationships: treats how relationships are developed and maintained and how online relationships go off line as well as situations when the opposite occur.
- Behavioural norms: reflect what is socially accepted in the community often summarized in the "netiquette" along with technical rules that regulate the online communication.

In multiple ways these four categories are continuously influenced by the pre-existing structure of the online community. This brings a complex picture of how these online phenomena must be analysed and understood. Hence, in the next section this model is applied to illustrate the structures and cultural context of online communities designed by patients themselves.

[4] Baym refers to Reid (1991) on work of Internet Relay Chat (IRC), Myers (1987a; 1987b) for the study of BBSs (Bullentin Board Systems) and Hellerstein (1985) on a study of a university wide network.

Patients' online communities (POC)

Pre-existing structures of POC

External context

The external context of POC involves three important aspects starting with central driving forces behind their existence. The performed questionnaire as well as the interviews shows that for many patients it is important to have the possibility to exchange experiences of their life situation as a patient with others in the same or similar situation. The patients find it important not only to receive social support but also to be able to help others. In the studies they often pointed out that: "I want to help others so they don't have to go through the same thing as I have"[5].

Many patients also want to get more information about their disease than they normally do e.g. at the doctor's office. For some patients this need also become the starting point to create an online community. However, the search for medical information has proven to be a difficult task. The interviewed initiators of POC reported that in their efforts to manage their health situation they found the information about the disease on the Internet inadequate since it is not always available in their own language and not presented in a comprehensive way easily accessible also to the laymen. They showed awareness of the difficulty of incorrect medical information on the Internet and over time they had developed an understanding of how to value different kind of sources. However, this was also an area where they called for "a much more active partaking by health care providing reliable information sources on the Internet", as illustrated by one of the interviewees.

The patients have collected and put together all kind of information about the disease and sometimes they have also translated it and finally they have presented it on a web page. Several of the interviewees expressed this process as a kind of "therapy" for them to cope with the disease and the difficult life situation. One of the interviewees even described the work with the POC as "one of the most important component in my own therapy". The idea to use the Internet was described as means to inform and support others as well as themselves. By the use of the interactive facilities other patients have joined gradually forming a community existing only online.

In addition, for some of the POC initiators in the study their disease is not that well-known and familiar to people in general. Therefore these patients have found

5 Since the research study was performed in Swedish all presented quotes from the observations, the questionnaire and the interviews are translated to English by the author.

the Internet useful also as a space for creating "disease awareness" and to influence the public opinion through the development of a POC.

Both the interviews and the observations show an important second aspect of the external context of POC. That is the accumulated experiences of the disease and interaction with health care providers held by the participating patients. These experiences are communicated e.g. by the personal stories available in the communities, sometimes on special web pages named e.g. "Others' experiences" or "Fellow patients' stories". Here patients tell their story of how they discovered the disease, about meeting the health care provider/professionals, how they were examined and diagnosed and how they have experienced different treatments. In addition, these informative practices are supplemented by an interpretive practice. Here patients draw upon their own and also others' experiences of the disease to help fellow patients to interpret what doctors and other health care professionals might mean. That is, they try to help each other to understand and make sense of e.g. results from tests or samples and examinations but also what has been discussed at meetings or phone calls with the doctor. In addition, patients also support each other on issues of how to act against health care providers or doctors. In the questionnaire the benefit of these accumulated experiences was often pointed out. Here described by one of the participants:

> "[...] you can discuss with others in the same situation and get an overview of how others deal with similar symptoms or how they experience the contact with the doctor. You get knowledge about your self that helps you to know what to ask for [...]"

The third aspect of the external context involves the Internet environment in general, which e.g. includes issues of physical location and Internet access. Participants in POC come from all over Sweden although some communities also have members from other Scandinavian countries as well as Swedes living abroad. A few of the interviewed POC initiators reported that their community have members of other nationalities living in other parts of the world. This means that the patients involved in POC would not likely have meet without the online community. Based on the questionnaire and the interviews the patients mainly access the Internet from their homes as well as their workplaces and seldom from publicly accessible computers in e.g. public libraries.

Temporal structure

In POC patients have the possibility to interact with each other asynchronous as well as synchronous. The observations shows that in some communities there are several facilities available in others just one. The most common feature of asynchronous communication is the discussion board. Here patients can discuss issues of their disease such as different symptoms, when and how a doctor should be contacted and strategies to get the best health care available. Other issues

concerns different kind of medicines, their effects and side effects and alternative treatments. In these discussions patients also give each other support and human understanding to handle a difficult and stressful life situation. In most of the communities in the study the discussion boards are open to any visitor but there are also examples when patients must register and become members to log in and participate.

Subjects formulated by the owner of the community often structure the discussions although sometimes the discussions are built in chronological order. This latter way to organize the discussion gives a general view of the frequency of the contributions to the debate. This however, varies between the observed POC in the study and according to the interviews this is also influenced by such occasions as when the disease has attracted mass media attention.

In POC they try to keep archives of former discussions available since these contains much information valuable to patients in several ways. Newcomers and the more experienced participants can use the archives as a recourse since many questions and issues discussed are recurrent. The interviewees emphasised the archives also as an important source of information for patients that, for some reason, do not actively participate in the discussions ("lurkers").

The same or similar issues as on the discussion boards are also debated on the e-mail lists. Since patients must register and be approved as participants the e-mail lists is a closed community or a closed part of a community. Here non-members or "lurkers" cannot share the information. The owners of the POC in the study are well aware of some patients' resistance to register and therefore some of the POC provide both an open discussion board and an e-mail list.

An additional kind of interaction is through the "guest book". The observations showed that the interaction here is characterised by simple messages to the community as such or as feedback of the web pages directed towards the owner. Sometimes contacts for private e-mail exchange are made here.

These different ways to communicate in POC are all examples of asynchronous communication. However, a few of the communities in the study also provide synchronous communication in chats where patients get together and chat on a set time and day of the week.

System infrastructure

Some of the interviewees described how their POC are built mainly by software available for free on the Internet while others have spend private means to get the system infrastructure to work. Also for the physical location of the web pages there are different technical strategies employed in the communities. Some are located at servers for free in exchange for having commercial advertising on the web pages while others choose to pay for a web hotel without the commercials. Others have also bought their own domain name.

In addition, due to the increased access to broadband in Swedish households some of the owners have had the possibility to locate the web pages of the online community to a server at the broadband company for free.

The different strategies for creating the system infrastructure is influenced also by such things as the owners time resources, strength and energy to work with the community as well as their access to and knowledge about the technology and its potentials. For some of the owners the handling of this kind of technology is a part of their professional work while others have learned (e.g. from family members) about the possibilities of the technology while using it. As explained by one of the interviewees:

> "[...] my son is only 21 years old, so I said to him "How do you make a homepage?" "Well, I can teach you how to do that", he said. So, we got this thing called Front Page and made a lot of mistakes [...] but eventually we got it running and he helped me to put in some pictures. So, it (the POC home page) started with two or three pages and today it has several hundred."

Group purposes

The purpose of a POC is often more than just one. The different purposes are linked and change as the community evolves. The group purposes presented here must therefore be considered as representations of the basic purposes common in POC.

The most apparent group purpose in all of the participating online communities is to provide patients with information. The communities want to *inform patients* about the disease in different ways and this is obvious in the online community in several ways, e.g. in text on the "welcome-page" but also by the design of the community pages linking the visitor to pages about "symptoms", "diagnosis", "treatments" or "The disease". Also "latest news" from the research is often presented. Under these headlines patients can find the information put together and sometimes also translated by the owner of the community. On the web pages it is also common to find a disclaimer that point out that the owner is not a medical professional and that the correctness of the information therefore cannot be guaranteed.

There are also several links to other sources for medical information sometimes both on-line as well as off-line. The basic idea is to help patients to become well informed and to increase their possibilities to handle their situation as a patient and to make informed choices in the healthcare system.

Some POC also provide technical information and service by links to web pages where software necessary to obtain some of the information in the communities can be downloaded. Examples are "Acrobat Reader", new versions of web browsers or software to open "Zip-files".

The purpose to inform is for many of the participating online communities closely related to the purpose to serve as a *learning environment* on the Internet. Several of the interviewed initiators of the online communities reported that when

they were diagnosed themselves they wanted to learn more about the disease in many ways. Since they had a hard time to find Internet resources covering their specific disease and situation as a patient, they started their own web page in order to support other patients learning about the disease. This purpose is pointed out in the online community by the emphasis of the idea of patients learning about their disease in order to become "their own expert". Also the extensive list of links to other sources of medical information, sometimes referred to as "recommended readings", makes the purpose clear.

All the patient online communities in this study have group purposes for creating *social support*. One of the interviewees described this as: "My aim is not only to provide facts but also...even more important...they should get response from someone who understands the hell they often are going through".

The general idea is to support discussions and personal interaction and to serve as a meeting place for fellow patients for social support and human understanding. This purpose becomes visible in the different interactive facilities provided by the online communities. The performed observations of POC shows that patients are encouraged to join the dialogue on the discussion boards or on the e-mail lists. The benefit for patients to participate is clearly pointed out on the web pages as well as in the ongoing discussions. There are also well-described instructions, both technical as well as social, for how to participate.

In most online communities the group purpose of social support is highly emphasized while in a few the purpose to serve as a means to *influence the public opinion* is pointed out as even more important. Since some diseases are not that well-know several of the interviewees pointed at the need to create "disease awareness" among patients and in society at large in order to affect the way these patients are treated in the health care system. These issues are also the topic of much of the information available on the web pages. There are e.g. comments about when the disease has attracted attention in mass media and there are also reprints of articles available originally published in newspapers. There is also information about legal cases concerning the disease. In addition, the purpose becomes clear in the expressed request for patients to participate in a societal discussion, online as well as offline about the terms for the specific patient group.

Participants characteristics

An important characteristic of participants in POC is how long the person has suffered from the disease. Most of the observed POC in the study have a "core group" of participants with long time experience of the disease and of contacts with health care. Participants of the questionnaire describe how these members frequently share their experience and enjoy providing the help and support they earlier missed themselves during their period of illness. On the other hand there are newcomers representing other characteristics with their specific questions and

need for extra support and understanding related to their stressful situation as newly diagnosed.

Besides the experience of the disease the participants also varies to the extent of technical experiences. Some are familiar with the technology because of their work practices while others have started to use computer technology as they became ill. Regardless of experience the patients wanted to have the opportunity to search for additional information on the Internet and this was often expressed like “the natural thing to do these days when facing illness”.

In addition, the performed studies shows that the disease in question also decides some of the participant characteristics. For instance, when a disease strikes only one sex the online community will consist of only men or women. In addition, there are also POC with participants in basically the same age since the disease might concern people in a certain age or affect them most in a certain period of their lives, like diseases related to infertility problems.

Social dynamics of POC

The pre-existing structures represent the basics of POC. However, alone these are not enough to give a comprehensive view of the communities. In order to deepen the picture the social dynamics of POC should be added. In the following this is accomplished by the examination of the *forms of expression* used together with *identities, relationships* and *behavioural norms* in the POC. In addition, influences of the pre-existing structures are also exemplified.

Forms of expression

A central characteristic of POC is to share each other’s stories of the disease. This means that the participants provide very personal and sometimes delicate information about the experiences of the disease and the changed life situation. The forms of expression can be categorized as personal and intimate. This is clear both on the special web pages providing these stories and in the discussion boards. However, in the study the interviewed patients reported that the dialogue on the e-mail lists often gets even closer since it is considered a private group.

The performed observations as well as the interviews showed that the use of a medical language and terminology also distinguish the forms of expression in the POC. This involves terms for different medical tests and examinations but also other characteristics of the specific disease.

An additional characteristic of the way patients express themselves in POC is the use of humour. Jokes about the disease or funny stories about how patients have been treated by health care are common. The stories report of comments or medical advises from doctors or other health care professionals that patients have considered completely wrong and ridiculous. These stories become group specific jokes and in some POC they have their own special web page. “Sometimes, you

just have to be able to laugh at all the misery" as expressed by one of the interview participants.

In various ways the forms of expression highlighted here are influenced by the pre-existing structures of POC. The life situation of suffering from a chronic disease (external context) and the need for social support contributes to the shaping of the vocabulary used in communities and the personal way of expression. Also the different interactive facilitates (temporal structure) and how they are used (system infrastructure) affects the forms of expression. For instance, in the chats available in some of the POC the conversations among the participants are synchronic and making the dialogue more direct and personal.

Both newcomers and patients with a long time experience (patients characteristics) of the disease contribute to the forms of expression in POC. For instance, newcomers often express issues of anxiety and fear of their health situation and this affect the use of a personal way of expression. On the other hand, patients with long time experience are aware of what someone just diagnosed are going through and this also affect their contribution to the dialogue about the disease. Also the group purpose influences the forms of expression. An example of this is the different expectations and different strategies for how to express one self when the purpose of the group is to provide social support and human understanding among fellow patients as opposed to POC were the purpose is to influence the public opinion.

Identities

In POC patients can participate anonymously or by using their real names. However, in some communities participants have to prove themselves as trustworthy if they use both a nickname and an e-mail address not indicating their identity. This means that the creation of identity is often based on the perceived quality of the contribution as well as the frequency of participation. To create an identity as well known or "famous" in the group participants also have to prove their experience and competence. If they succeed they get others' trust and are considered as reliable in discussions. Some of the interviewees emphasised that this identity also becomes an important resource in the POC as someone who can give support to many and answer various questions about the disease.

In addition, the way identities are created in POC is related to the personal style of the community owner. His or her strategies for how to run the community play a central role. An example is decisions about such things as whether the community should be open to any visitor or if a membership should be required. If a membership is needed to join it is also the owner who decides the criteria for who should be allowed to become a member. The strategy applied by one of the owner was described like:

> "[...] they should also have been writing during a period of time and showed that they are active on the list. Activity involves both asking and answering. Not just to give answers and no only to ask. You have to share, you know [...]".

By the work to initiate and run the POC the identity of the owner is created. However, this identity has for many changed as the communities have evolved over time. The development has often put them in a leading and central position not only for the online community as such but also as an important support person for patients needing help. For some owners this has become so stressful that they have chosen a strategy to reduce the focus on themselves in the POC and direct as much attention as possible towards issues of the disease. Still, in most of the POC in the study the owners play a central role as coordinator of information as well as moderator of the discussions. They also have the main responsibility for the development of the community.

The experience of the disease (external context) and the situation as patient (participant characteristics) together with the exchange of rather personal information makes the creation of identities oriented towards anonymity but with gradual disclosure either of true identity or accepted identity as a "famous" group expert. Also a group purpose directed towards support and human understanding of fellow patients will influence the creation of identities in a similar way.

In addition, the temporal structure and system infrastructure for participation in discussions is also reflected in the creation of identities. Following an ongoing discussion or reading a past one in the archives shows e.g. who has been active in discussions, who is considered reliable etc. This brings a picture of the participants in the community that affect the creation and maintenance of identities.

Relationship

POC only exist online but in several of the participating communities the activities online has resulted in get-togethers off-line as well. Several of the interviewed patients reported that when patients have participated for a while and gradually revealed more of themselves some of them have discovered that they live in the same town or in the same part of the country. The patients then arrange informal meetings at e.g. a café. The purpose is just to talk directly to each other and to see what their online friends look like in real life.

In some of the POC in the study also the opposite situation exists where patients who know each other off-line also have developed an online relationship.

An additional example of how relationships are formed in POC is when "off-topic lists" are created. This happens when patients who get to know each other in the community want to develop their online relationship and to be able to discuss other topics than those related to the disease.

One of the underlying ideas of POC is to meet fellow patients and as thus the pre-existing structures affect the creation of relationships. When the group purpose is to support each other despite geographical distances (external context) the creation of relationships is something the participants strive for. However, that is not to say that all patients have a need for the same kind of relationship. The need of newcomers might be different from those who have long time experience of participating in a POC (participant characteristic). The design of the system infrastructure with diverse set of interactive facilities that allows for different levels of privacy together with various temporal structures influence the forming of relationships in POC.

Behavioural norms

The observations of the POC illustrate that there are often both technical and social guidelines for how to participate in the discussions. The technical part involve such instructions as for how to quote others when answering e-mails and how to correctly make contributions on a discussion board.

The rules for "netiquette" often serve as guidelines to inform the participants what is socially accepted or not in the discussions. In the POC it is also pointed out that since the participants are patients sometimes in the most difficult life situation and that some issues discussed concern delicate patient information it is even more important to keep the dialogue in good manners. Unfortunately these guidelines is not respected by all participants and most of the interviewed initiators of POC have experiences of 'flamers' who insult others, ruin the dialogue and bring the discussions to concern issues far beyond the original ones. When these things occur the owner normally excludes the flamer from the community.

There are also other occasions when participants are excluded. Sometimes people who are not suffering from the disease pretend to be patients and join the group. These people might not be flamers and their reasons for joining the communities is not always known. The interviewees reported that some of these persons want to use e.g. the discussion board for political discussions while others just want to talk to someone. Therefore, in some of the POC the use of a trial period is employed. For instance, a patient who wants to become a member of an e-mail list will have to prove him/her self in the community by actively participating in the discussions and prove their knowledge of the disease and the situation as a patient enough to actually be a patient.

Also the shaping of behavioural norms is influenced by the pre-existing structures. The driving forces (external context) involved in the need to meet other patients also brings the necessity to form the manner for how these meetings technically and socially can be structured. In addition, if the purpose of the community is mainly oriented towards support and human understanding norms for social behaviour becomes vital. Since POC continuously get new participants

with different experiences of Internet use and participation in online communities (participants characteristics) the way the discussions are performed and the accepted social behaviour needs to be communicated.

The system infrastructure available with various possibilities for dialogues using both asynchronous and synchronous (temporal structure) interaction influences the creation of behavioural norms. Representing different technical facilities discussion boards, e-mail lists or chats involve different technical behaviour like for how to join and how to participate.

Discussion

The results bring a fine-grained picture of POC as an emergent online phenomenon. By applying Baym's model contextual structures as well as the community culture becomes visible. The model brings out more than a specification of the entities that constitute this kind of online communities since it also reveals the social dynamics of the discourse and the way relationships, identities and norms are developed.

Further, the use of the model contributes to the highlighting of two important underlying needs of patients essential for the existence of the online communities. Therefore, in the following discussion these needs as central aspects of the external context of POC and their contribution to the specific social and the technical design will be focused. In addition, the discussion will also show how the results can inform design of emergent forms of Internet use between patients and health care providers.

To be diagnosed with a chronic disease is a very stressful and difficult situation that often involves a changed life situation for the individual as well as for his or her family. This generates needs to create meaning of the disease and to understand the new situation (Madara, 1997). For many patients increased knowledge of the disease and discussions with fellow patients becomes a strategy to deal with the uncertainty of the situation.

This means that patients develop needs *to get informed* and *to interact with others* in the same situation (Madara, ibid.). These needs become the fundamental driving forces of POC and also important components of the *external context* making POC unique as online communities.

The driving forces are shaped by a life situation beyond control of the individual and that make POC different from other "communities of interest". People do not start or join these online communities because they have taken a mere interest in a disease but because their life situation has changed due to causes they cannot control themselves.

The driving forces highly influence the design of POC. The needs to interact and to get informed trigger the initiation of POC and shapes the *group purposes*. Although the purposes may vary they all have their basics in the requirements for

additional information and communication with fellow patients. This also triggers different categories of patients to participate, which influence the *participant characteristics*. Further, the driving forces also influence the means by which patients try to fulfil the needs. This results in the search for and use of various interactive facilities creating the *system infrastructure* and it also influence how patients design their interactions in terms of *temporal structure*. Additionally, the driving forces highly influence the development of the *social dynamics* of POC. The underlying need to learn more about the disease and to share a difficult life situation with others sets the frame of the discourse and also shapes the community culture in which the social behaviour is decided and developed.

This specific design and the interrelated dependencies between the pre-existing structures and the social dynamics of POC provide several important areas to analyse from a design perspective. However, with the purpose to introduce a discussion of how the experiences of POC can inform design the following will focus the main driving forces of these online communities as implications for design of emergent *Internet based communication between patients and health care providers*. The information technology use referred to is the kind emphasised by Rice (2001) that involve both health care providers and patients in the development future health communication. Providing a concrete example Leimeister et al (2002) discuss this kind of utilization of the technology in their efforts of designing mobile health communities for cancer patients involving both health care providers/professionals and patients.

First, the design must allow for patients to become well informed. That is, providing patients with medical information of high quality presented in their own language and in a way accessible also to the laymen. The issues of providing patients with reliable medical information online and how this successfully can be implemented are ongoing discussions (c.f. Ferguson, 2000; 2002; Eysenbach & Diepgen, 1999). However, in this study it is highlighted by patients' requirements for health care to increase their activities in providing online resources that guarantee the correctness of the medical information.

Further, the patients have high demands on the news value of the information. This means that the information must be updated regularly and complemented with news from ongoing research in the specific field.

Also, the information provided must not only give general information about the disease like causes, symptoms, treatments and prognosis but also specific information (Leimeister et al, 2002). This involve issues related to the individual case of illness like explanation of particular test results, how medications can be used and combined or further examinations and treatments that a patients should discuss with his/her treating physician. It also involves opportunities to discuss additional medical information available on the Internet with health care professionals.

Second, the design should offer patients the opportunity to get contact with fellow sufferers. The benefits for patients sharing their experiences are well known (Reeves, 2000) and how this supports the self-help processes (Finn, 1999; Preece, 1999) involved. This concerns the possibility to personally receive social support as well as helping others (Madara, 1997; Reeves, 2000). This is also important since the Internet never rests and that patients can use this resource to contact others at any time. Such facilities for online meetings between patients are especially valuable for patients with physical or mental difficulties to participate in off-line activities (Finn, 1999).

Additionally, it is important to keep in mind that patients have different strategies for how to utilize the Internet for self-help purposes and this concerns also different views on anonymity and the participation in online activities. Many patients show awareness of the importance and personal benefits involved in the possibility to follow patients' discussions without actively participate. This brings the idea that the design should support these patients, that for some reason do not participate, to learn from others and have their own story confirmed. On the other hand, there are also patients feeling uncomfortable with arrangements allowing for "lurkers" to follow ongoing discussions. Therefore, the design must *also* provide more closed spaces for online debate requiring registration or membership, making "lurking" more difficult.

Arrangements as outlined above would be beneficial also for health care providers or professionals. The kind of information provided in patients' interaction with each other is difficult for health care to communicate to patients. Therefore, an online health care resource, wholly or partly, devoted to social support can be a valuable resource for health care to guide future patients to.

The suggested design implications demand an active participation of health care providers to establish an Internet based communication and by means of the technology support patients in a new way in their efforts to make sense of a disease and a changed life situation. This implies a way to use the Internet for a continuing interaction creating on-line communities involving both healthcare providers and patients (Josefsson, 2002). According to Mittman & Cain (2001) this area of community building for patients and caregivers belongs to one of the "*leading-edge applications associated with the future of the Internet in healthcare*" (pp. 48).

In order to develop Internet use towards a health care resource as proposed future work should consider both technical and social issues (Preece, 2000) in order to increase the knowledge of how to make the Internet serve the interests of patients as well as healthcare. This paper contributes by drawing attention to a unique kind online communities designed by patients themselves and the driving forces underlying the development of POC. The reported study only considers a limited number of Swedish patient online communities chosen from specified criteria. However, the presented picture provides an important example of the

emergent use of the Internet in everyday life designed by individuals and how studies of these online phenomena can inform design.

Conclusions

In this paper the characteristics of patients' online communities in Sweden has been identified and analysed using Baym's model of "*The Emergence of On-Line Community*". The purpose has been to increase our understanding of how individuals design online social support and how this can inform design in a wider perspective. By applying the model the paper presents a fine-grained picture of POC covering both the contextual structures as well as the community culture. Further, the model contributes to the highlighting of two important driving forces of POC (*to get informed* and *to interact with others* in similar situation). These serve as a basis for the introductory discussion provided on how the experiences can serve as implications for the emergent design of Internet based communication between patients and health care providers.

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When Users Push Back: Oppositional New Media and Community

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Abstract. The progressive privatization of Internet infrastructure in the U.S. throughout the 1990s fostered the resurgence of a mass media-style "pipeline" model of online content distribution favored by the media and entertainment industries. Nonetheless, and despite various attempts at suppression by corporations and law enforcement, a diverse community of artists, activists and citizens has found the Web and related technologies to be effective media for expressing their ideas and interests. In this paper *oppositional new media* are examined as a means of response and resistance to a popular culture that many groups regard as dominated by consumerism, political apathy and cultural and economic oppression. Cases are presented to illustrate key genres of oppositional new media, including the responses of mainstream corporate, government and law-enforcement authorities. The paper concludes with an overview of characteristics of oppositional new media and their implications for establishing and maintining community.

Prologue: The Internet and 1990s Media Ecology

> *"Once upon a time there were the mass media, and they were wicked, of course, and there was a guilty party. Then there were the virtuous voices that accused the criminals. And Art (ah, what luck!) offered alternatives, for those who were not prisoners of the mass media.*
>
> *"Well, it's all over. We have to start again from the beginning, asking one another what's going on."*

M. Huysman et al. (eds.), Communities and Technologies, 391-405.

Umberto Eco, "The Multiplication of the Media" (1986: 150)

"Revolution has to be reinvented, that's all."

Guy Debord, "Instructions for Taking up Arms" (1981 [1961]: 63)

When the World Wide Web and browser technologies were introduced in the U.S. in the early 1990s, technology advocates believed they had the potential to expand Internet use beyond the ranks of elite academic, government and private-sector corporate users. Observers like Stewart Brand and Howard Rheingold, among others, predicted that relatively inexpensive client-server architecture would at last give "ordinary" or "marginal" communities and groups a powerful mediated voice that would allow them to extend their ideas and influence in ways that the few-to-many, top-down, content-distribution model of mass media had prevented. Groups like the Well in Sausalito, California and Berkeley's Community Memory, with their roots in the 1960s counter-culture, embodied the early ideals of empowerment and participation, in Rheingold's famous phrase, of "homesteading on the electronic frontier" (1993).

In fact, Web browsers and the rapid accumulation of Web-based content did help boost hardware and software sales and subscriptions to Internet service providers in the 1990s, particularly among home users. But it wasn't just the availability of content that drew novice users: MUDs and MOOs flourished, chatrooms proliferated, and email was rediscovered to be the fabled "killer app" for personal and leisure uses as well as in the workplace. New opportunities for interpersonal communication, as much as mainstream media content repackaged for the Web, attracted people to the Internet who had never thought of using computers before. Some observers predicted the end of mass media, as Web browsing, chatrooms, email and games began to draw audiences away from broadcast and cable television, radio and theatrical movies.

Meanwhile, the traditional media industries looked at browsers and the World Wide Web and saw a new frontier of a different sort, one of advertising, distribution and sales. They rapidly recast themselves as "content industries," whether their products were books, periodicals, movies, recorded music, or any other format. They collaborated with software firms to repackage or bundle their products with other kinds of "software." As the decade went on, they built alliances with telecommunications firms to gain greater control over the new media infrastructure, particularly the "final mile" of cable or telephone wire into the home. They anticipated a surge of demand for entertainment content delivery that would require major increases in bandwidth.

Throughout the 1990s the conglomerate media-telecoms-computing firms lobbied the U.S. Congress, the Justice Department, the Federal Communications Commission, and any other agencies where they could wield influence, to shape a

more advantageous legal and regulatory environment. The Federal government obliged, in the form of the Telecommunications Act of 1996, the Digial Millennium Copyright Act (DMCA), and the Bono Copyright Term Extension Act, among other legislation. The Clinton administration appointed FCC commissioners who ushered in a market-oriented era of media deregulation. In the name of reducing restrictions on corporate "speech" (a movement begun under Presidents Reagan and Bush), media ownership constraints were substantially weakened, and equal-time and must-carry rules were abandoned.

At the same time, in the prevailing rush toward privatization, the "property" metaphor swept every corner of the media, computing and telecommunications industries. The radio frequency spectrum -- formerly considered a scarce natural resource and therefore a public good -- was redefined as an over-abundant commodity and important segments were put up for auction. Internet service providers (ISPs) such as AOL eschewed longstanding service models from telephony, postal mail, or publishing. Instead, they claimed both the systems they operated and the messages they carried (e.g., subscribers' email) as their private property and subject to monitoring and control.

Meanwhile, in what copyright scholar Jessica Litman tagged the "intellectual property epidemic" (1994), intellectual property rights were extended to entirely new types of information (including previously-exempted facts like mathematical algorithms, sequences of genetic code, or the "click" of a computer mouse to order merchandise online), and for unprecedented periods of time. New "anti-circumvention" provisions of the DMCA prohibited the creation or use of any new technology that might conceivably used to infringe intellectual property rights -- whether the technology is actually used that way or not (see the *Hacker Quarterly* case, below).

The dot-com collapse at the end of the decade led to a precipitous shake-out of smaller enterprises and start-ups across the media, telecoms and computing industries. In many cases their assets were sold to the larger surviving firms, thus further concentrating ownership into a handful of global-scale companies. In this climate, worries about personal privacy became widespread in the U.S. and prompted cover stories by major news magazines, horror stories about identity theft and telemarketing abuses in the popular media, consumer protests, and the proposal of new legislation.

But those worries were forgotten in the wake of the September 11, 2001 terrorist attacks. Shortly thereafter, initiatives like the Patriot Act gave the U.S. government sweeping new powers to withhold and control public information and to monitor the movement, activities and communications of citizens.

Now, a few years into the new century, it would seem that (to paraphrase Mark Twain) the death of the centralized, industrial-style mass media model has been widely exaggerated. After the initial shock of the Internet challenge to existing markets, media industries have responded by attempting to extend the mass

content delivery model to online content "consumption." They have vigorously fought any distribution scheme or technology -- peer-to-peer computing being the most vivid example -- that threatens its gatekeeping, rent-extracting role in the distribution and circulation of information in whatever form.

Though a glut of bandwidth (especially fiber-optic networks) was built in the 1990s, those nets have largely remained dark because the handful of major media conglomerates that control them are unable or unwilling to generate revenue by allowing users to create and share content among themselves. Broadband services to the home (i.e., digital subscriber line [DSL] and cable modem services) were built asymmetrically, with much more downstream capacity (from the network to subscribers) than upstream capacity (from consumers to the network), reflecting a view of households as primarily consumers, rather than producers, of content. Indeed, the widely-heralded, late-90s goal of streaming video to the home via high-speed data networks has quietly been shelved. At present, the U.S. has one of the slowest "high-speed" consumer broadband networks in the world, and lags most of Europe, Korea, Japan, and other nations (Belson & Richtel, 2003).

The Internet and Media Ecology Today

In this contemporary "media ecology," then, what has happened to the early vision of small groups and individuals gaining greater political and economic voice and participation online? In fact a wide array of community groups, political and cultural activists, artists, and ordinary citizens have found innovative ways to use new media technologies and content to express their ideas and opinions online, despite the legal, economic and technological barriers that have been put in their way.

Collectively, these new forms might be called *oppositional new media*, echoing what Lovink and Richardson (2001) call "the media of opposition." They are oppositional in the sense that they constitute a response, reflection, critique, parody or rejoinder to situations and events created by or portrayed in mainstream media. *Oppositional new media* is an umbrella concept that encompasses a variety of forms and content. For example, Geert Lovink and his associates have coined the term *tactical media* and in different works describe its relationship to similar forms, such as alternative media. For the purposes of this paper, however, both tactical and alternative media are included as oppositional new media.

In terms of both ontent and technology oppositional new media evolve, bottom-up, in response and resistance to a media environment that some groups regard as being fully saturated with consumerism and political spin designed to impress rather than to inform or instigate. For these users, the Internet, mobile telephony and related infrastructures are tools for creating hospitable spaces to develop and express unpopular or even 'fringe' ideas, and to resist the homogenization of mainstream computing, telecommunications, media and

culture. The sites they design and build are necessarily low-budget, quick-response forms of communication that are specifically intended to "cut through the clutter" -- sometimes, by borrowing and subverting it. When they are well-designed and thoughtful, these sites can be memorable, effective, and can motivate impassioned response and participation. They advance the "alternative" philosophy of the early Internet proponents and visionaries, but they also depart from previous forms in important ways.

Groups like ®™ark and the Surveillance Camera Players may not have the cachet, pundits, or Microsoft bankroll of *Slate*, and blogs may never reach more than a few dozen loyal readers. Nonetheless, new genres of digital media have become a sort of laboratory for tinkering with political and cultural expression. In the rest of this paper several important genres of oppositional new media are described and illustrated with recent cases. The characteristics that make oppositional new media a distinctive form of communication, and its role in fostering community participation and involvement, are discussed.

Culture Jamming

The term *culture jamming* is often traced to an influential manifesto by media critic Mark Dery (1993), who himself credits the experimental band Negativland with coining the phrase. Dery defines culture jamming as "media hacking, information warfare, terror-art, and guerrilla semiotics, all in one." It is "directed against an ever more intrusive, instrumental technoculture whose operant mode is the manufacture of consent through the manipulation of symbols" (p. 5). Dery sets out an agenda for culture jamming, and describes a number of projects. Though his essay is now about ten years old, and reflects the media technologies of its time (for example, the reconfiguration of billboards by the Billboard Liberation Front [BLF], the overnight poster blitzes of artists like Robbie Conal, or media hoaxing), the principles and influences Dery cites are still at work today. For example, the BLF can be seen as a predecessor of contemporary website "spoofs" like gwbush.com and Dow-Chemical.com, supported by ®™ark (discussed below).

MIT Media Lab graduate student Jonah Peretti calls culture jamming "a strategy that turns corporate power against itself by co-opting, hacking, mocking and re-contextualizing meanings" (p. 1). In a project he called "My Nike Media Adventure" in an essay in *The Nation* (Peretti, 2001a), Peretti ordered a pair of running shoes from the firm. As a way to associate Nike with freedom and flexibility, the manufacturer offered a customization service which let consumers order shoes bearing their own choice of words or slogans. Peretti ordered a pair emblazoned with the word "sweatshop," a reference to Nike's overseas labor practices. They refused to fill the order, and their email response to Peretti was

the start of an email correspondence in which Nike never actually addressed the labor issue.

Afterwards, Peretti forwarded the correspondence to a few friends via email. But he didn't anticipate that online, the message would spread exponentially among friends of friends, to school and activist groups, to blogs, and so on. Eventually Peretti's story was picked up by online news sites (e.g., Slashdot.com, Plastic.com), which are themselves monitored by the major print and broadcast news organizations. Soon Peretti's project crossed over into the mainstream media and he found he had become something of a short-lived celebrity. He traced the remarkable burst of Web traffic about the story and has posted data about his own email traffic at his website (Peretti, 2001b). Peretti argues that the case demonstrates the power of "micromedia" and "middle media" (online news sites) to influence mass media.

Another, more complex example of culture jamming is found in the nonprofit arts organization ®™ark (pronounced Art-Mark), which channels philanthropic funding to artists and art projects that challenge corporate and government abuses of power and consumerism. ®™ark-funded projects include the switching of voice chips in Barbie and GI Joe dolls, which were subsequently sold in a major toy retail outlet (the "Barbie Liberation Organization"); "Deconstructing Beck," a critique of the popular musician's image and music sources which ®™ark distributes on CD; and GWBush.com, a spoof website for the George W. Bush 2000 Presidential campaign. ®™ark also supported the art collective etoy.org against attempts in 1999 by the now-defunct retailer EToys.com to prevent the collective from using their own domain name.

®™ark figures prominently in another recent controversy, sparked by activist arts group and ®™ark client The Yes Men (Carr, 2003; "Cyberspace artists," 2002; Delio, 2002; Web Host Industry Review, 2003). On December 3, 2002, the eighteenth anniversary of the toxic gas leak at Dow's Union Carbide plant which killed thousands of people in and around Bhopal, India, The Yes Men posted a parody web site for Dow Chemical which used Dow's graphics but which recounted the company's role in the Bhopal disaster, and linked it to the ®™ark site. Both The Yes Men and ®™ark -- as well as hundreds of other arts organizations in New York City, including the magazine *Artforum*, P.S. 1, and Mabou Mines -- were subscribers to an ISP, The Thing, which provided Web connections and design services to area artists and arts organizations. Citing the DMCA, Dow complained to The Thing's telecommunications provider, NTT/Verio.

In response, Verio shut down The Thing's whole network for 16 hours, including all of The Thing's other clients as well as ®™ark, until the offending site was removed on December 4. Despite the fact that the site was taken down, however, Verio's attorney's soon informed The Thing that their service would be permanently terminated at the end of February 2003. Dow claimed copyright

infringement, violations of the DMCA, and defamation, but those claims were never legally tested; instead of addressing the offending parties directly, Dow "circumvented" the usual legal channels and simply pressured the upstream bandwidth provider, demonstrating that all that is needed to control speech online is to control the network. The Thing's business has been damaged, and according to the *Village Voice*, as of January 2003, the owner, Wolfgang Staehle, was considering moving to a European ISP, where the DMCA does not apply.

A wave of culture jamming projects has also emerged in response to the growing use of surveillance cameras on private property and in public spaces in the U.S. For example, artists have created websites with maps of all the surveillance cameras in certain New York City neighborhoods, and experimental dance projects have been performed for the cameras inside ATM lobbies (Markoff, 2002). New York artist Michael Naimark has created an ongoing project using inexpensive laser pointers to temporarily disable public surveillance cameras as he walks through public spaces. The technical details for the project are provided at his web site (Naimark, 2002). A drama troupe, the Surveillance Camera Players, stages performances of classical and contemporary drama for the benefit of surveillance cameras in public spaces (Rimensnyder, 2001; see also the Players' web site, http://www.notbored.org/the-scp.html).

Today, culture jamming is an increasingly familiar tactic in progressive-left politics and cultural circles. Nor is it limited to the Internet or information technology: the print magazines *The Baffler* and *Adbusters* (and their websites) carry ongoing critiques of consumerist ideology in American media culture. The editor of *Adbusters*, Kalle Lasn, has published a polemical call to activism, *Culture Jam: How to Reverse America's Suicidal Consumer Binge -- and Why We Must* (Lasn, 2000). Andrew Boyd, a New York City activist, has been called the "Tony Robbins" of the culture jamming movement (Caldwell, 2003), and offers "Culture Jamming 101" seminars on university campuses in which he encourages others to create their own projects.

Hacktivism

A second genre of oppositional new media is more likely to involve software engineers than artists or critics. Hacktivism employs the technical expertise of computer professionals who object to political or commercial restraints on access to information and information technology, or as Mark Dery puts it, "Outlaw computer hacking *with the intent of exposing institutional or corporate wrongdoing*" (1993, p. 5; italics in the original). Hacktivists' activities range from the creation and distribution of "open source" software, or freeware (such as that used to create blogs; see below), to the development and distribution of decryption programs, to deliberate sabotage such as denial of service (DOS) attacks.

In recent years the term "hacker" has been used by law-enforcement agencies, government and for-profit interests, and repeated in the popular media, as a synonym for criminal. However, the term originated within the computing and software community itself. As far back as the 1970s it was a term of admiration for someone especially adept at creating elegant solutions ("hacks") to difficult programming problems. Certainly, some early hacks involved programmers who figured out how to enter prohibited or restricted systems (e.g., telephone companies, the U.S. Department of Defense). However, these projects were typically intended to demonstrate the skill of the programmer, not to damage or disrupt the system. Indeed, among programmers a distinction is still drawn between skillful, "good-guy" hackers, who often deliberately demonstrate the vulnerabilities or bugs in systems and software programs, for example, and explicitly criminal "crackers."

One of the most prominent recent cases of hacktivism involved Eric Corley, the publisher of the online magazine *2600: The Hacker Quarterly*, and the related website (www.2600.com). In 2000, the magazine published code (DeCSS, or Decrypt Content Scrambling System) that would enable users to decrypt and view DVDs on computers running the Linux operating system, rather than exclusively on Microsoft OS-based systems. The code had been developed by a Scandinavian programmer, who shared it online without charge. The program is not illegal in Europe; nonetheless, Universal Studios sued Corley and *2600* on the grounds that the publication of DeCSS violated the Digital Millennium Copyright Act. Corley invoked his First Amendment speech and press rights as a defense. Nonetheless, the Federal circuit judge's ruling in 2001 not only prohibits Corley from publishing DeCSS; it also enjoins him from publishing links to any other site or source for the same code, even where it is legal.

Corley is appealing the ruling. (For a current list of the legal and media documentation of the case, see the *Hacker Quarterly* web site, http://www.2600.com.) But in the meantime, Corley's supporters in the programming community have launched a protest. On the principle that works of art are unambiguously covered by First Amendment speech protections, as online publishing apparently is not, they have set up an online art gallery at Carnegie-Mellon University of works which incorporate DeCSS code, including paintings, sculptures, apparel, and so on (http://www.cs.cmu.edu/~dst/DeCSS/Gallery/).

Affiliation Networks

A third category of oppositional new media takes advantage of the ability of digital media systems to connect like-minded but geographically dispersed people who may be otherwise unacquainted through conventional social channels, and diverse content (for example, through hyperlinking). These sites can be thought of as affiliation networks. For example, peer-to-peer (P2P) computing lies at the

heart of recent controversies about Napster and the sharing of music files online. P2P systems help people share files of information, effectively by making their hard drives available to other members of a group. There is no central repository or location for the information; rather, P2P systems allow group members to locate and retrieve each other's materials.

There is nothing inherently "oppositional" about P2P systems. However, one of the first, Napster, became a *cause célèbre* when major entertainment firms -- principally, record companies -- shut down the network. The firms claimed that the P2P architecture allowing users to share music files also made it possible to make illegal copies of copyrighted material, and thus violated the DMCA (and implying that users had no fair use rights to recordings they might already own).

As a result of its legal problems, Napster is gone; its software and patents have since been bought by the media giant BMG. But other P2P networks (e.g., Gnutella, Kazaa; see Woody, 2003) with different and much more distributed architectures are still operating despite industry efforts to stop them. Again, the DMCA is being invoked to prohibit a system architecture in the name of protecting intellectual property rights, at least until the music industry devises its own ways to use P2P. Both operators and users of the surviving P2P systems increasingly view their activities as a form of resistance to the market power of an oligopolistic industry.

However, it might be argued that peer-to-peer computing is not about copyright infringement per se; rather, it is a technological model based on interpersonal networks and people's shared interests. It is a fluid, social and cooperative environment by definition, and regulators prohibiting P2P may in effect be attempting to prohibit certain forms or aspects of social association.

Another cooperative form has become something of a craze in the last few years: blogs (short for "web logs"). Blogs are essentially running commentaries posted online by authors who invite readers to follow along, respond and interact. Authors create them using simple-to-use software that can be obtained for little or no charge online (see, for example, blogger.org and moveabletype.org). A fair proportion of blogs are devoted to political and cultural commentary, and many offer a point of view that is frequently marginalized or suppressed in the mainstream media.

Blogs differ from regular web sites in that they are not merely postings of static content, like an online newspaper; instead, readers can comment and respond to postings, engage with the author and with each other about the postings, link to related websites or "rings" of other like-minded blogs, and so on. Unlike listservs, they are ordinarily hosted and authored primarily by an individual or a small group.

The volume of blogging has increased so much that blog indexes and directories have been developed to help readers find sites they might like (e.g., portal.eatonweb.com). "Top blog" lists are found at directory sites, on individual

blog sites, and on other websites as well. News organizations regularly monitor popular or controversial blogs.

Peer-to-peer systems and blogs are not the only forms of oppositional new media that are based on affiliation and networking. For example, new "meetup" web sites help people with similar interests get together in person for meetings, such as political events; indeed, mainstream political campaigns have begun to take advantage of these informal meetings (NYT, March 13 2003). Text messaging via mobile phones has become another important form of sharing information and socializing. *Indymedia* sites provide local news reporting, commentary, and critique of mainstream news; its precedent is the 1960s alternative press (Deuze, 2003).

However, the key factor across this genre is the use of digital technologies to share information and interact with widely dispersed, like-minded others outside of traditional institutional or organizational structures. As such these affiliative forms may help foster new spaces for civil society or the encouragement of social capital in Putnam's sense (2000).

Features of Oppositional New Media

The preceding discussion is hardly a comprehensive inventory of the various established and emerging forms of online media that take a critical or oppositional stance to the political, cultural and economic status quo. But it gives a sense of the range of projects and activities involved, and suggests that these efforts share several key characteristics.

The first feature of the various genres of oppositional new media is their *small scale*; as Jonah Peretti says, they are "micromedia." In Garcia and Lovink's (1997) phrase, they are "what happens when the cheap 'do it yourself' media...are exploited by groups and individuals who feel aggrieved by or excluded from the wider culture." They are run with a minimum investment -- for example, ®™ark solicits philanthropic donations amounting to no more than a few thousand dollars per project that it supports. As a result, the projects and their related web sites give visitors a sense of intimacy, of personal involvement, of advocating particular issues and interests, of "subcultural immediacy" in Kahn and Kellner's phrase (2003). The visitor to the ®™ark or DeCSS Gallery sites gets a sense of being an insider, an initiate. At the same time, however, because the sites are connected to the world-wide Internet infrastructure, they have the potential for global reach and impact; as Kahn and Kellner put it, they have the potential of contributing to "globalization from below."

The second important characteristic of oppositional new media is that they are *interventionist*. They "introduce noise into the signal" (Dery, 1993), they "jam dominant media transmissions" (Hebdige, 1979, quoted in Kahn & Kellner, 2003). They are intended to subvert taken-for-granted meanings in a way that is

obviously manipulated: "Culture jammers do not exist without corporate billboards" (Lovink & Richardson, 2001). In this sense, they are the legacy of earlier political parody and subversive art, like that of the World War II collage artist John Heartfield (Dery, 1993; Huhtamo, 2003).

The point of oppositional new media is that they either constitute intervention and action in and of themselves (e.g., performances for the benefit of surveillance cameras and whomever is watching at the other end; or the Carnegie-Mellon DeCSS Gallery), or they invite and motivate intervention by others (e.g., ®™ark's "Mutual Funds," which solicit "investors" for prospective artworks, or Michael Naimark's instructions for disabling video surveillance cameras; see also Braman, 2002). As Mark Dery points out in his 1993 essay, those who engage in culture jamming, who are making counter-intuitive interpretations of the dominant culture, are practicing the "guerrilla semiotics" advocated by Umberto Eco in 1967:

> "What must be occupied, in every part of the world, is the first chair in front of every TV set (and naturally, the chair of the group leader in front of every movie screen every transistor, every page of every newspaper)...The battle for the survival of man as a responsible being in the Communications Era is not to be won where the communication originates, but where it arrives" (Eco, 1986, p. 142).

The third key characteristic of oppositional new media is that they both demonstrate, and expect from their audiences, a relatively high level of *visual, cultural, or subcultural literacy*, as Kahn and Kellner put it (2003). They show a "hyper self-reflexivity about the nature of pop culture" (Collins, 1995, p. 2), an awareness and referentiality that can reinterpret the familiar because the sites' authors assume their audiences all know it, too. In this sense they are postmodern: issues, images, buzzwords, attitudes, are chosen, captured, subverted, coopted, fragmented, recombined and re-presented in unexpected (and hopefully felicitous) ways. Garcia and Lovink (1997) observe that they possess an "aesthetic of poaching, tricking, reading, speaking, strolling, shopping, desiring."

In this respect oppositional new media can trace their roots to the Situationist concept of *détournement*, the "strategy of diverting elements of affirmative bourgeois culture to revolutionary ends, of distorting received meanings" (McDonough, 2002: xiv). Détournement was exemplified by the uses of comics, pornography, and other images from popular culture in the posters, films, and manifestoes of the student uprising of May 1968 in France (Viénet, 1981 [1967]).

A fourth feature is that oppositional new media are *ironic*, playful, humorous, campy, or parodic (Braman, 2002). "[Culture jamming] is immature...[it] celebrates the possibility of ironic, humorous and contradictory political actions" (Peretti, 2001). Oppositional new media "...do not take themselves that

seriously...They know how to laugh" (Lovink & Richardson, 2001). The absurd is abundantly obvious to the designers and makers of oppositional media, and their aim is to inspire outrage by pointing out and mocking the absurdity. As intellectual property expert Jessica Litman has observed about the current copyright situation, "Members of the general public commonly find copyright rules implausible, and simply disbelieve them" (Litman, 2001, p. 29). Even situations that are not humorous or ironic on their face can quickly be turned to that purpose, as the CMU DeCSS Gallery does with the Eric Corley/*Hacker Quarterly* injunction.

The fifth characteristic of oppositional new media is that they are *liquid*, both in terms of their ephemerality in relation to the current cultural context, the meanings they draw upon and reinterpret, and the nature of electronic information and information technology generally. They are "...capable of taking risks, even if this means they might self-destruct in the process" (Lovink & Richardson, 2001). They are notable for their "*mobility*, [their] flexible response to events and changing contexts" (Meickle, 2000).

Jim Collins (1995) argues that new media destabilize the evaluative criteria of traditional culture and relegitimizes those criteria on new grounds: first, they create and enable new kinds of cultural collecting, archiving, and archivists; and second, they disperse cultural authority from a few institutional centers to multiple new sites (pp. 28-29). As social theorists like Manuel Castells would argue -- and the practical case of the P2P network Kazaa materially demonstrates (Woody, 2003) -- neither the networked form of the infrastructure nor the content of new media have a stable form or fixed structure; they organize, disorganize and reorganize recursively.

Conclusion

To conclude, then, the preceding cases and the characteristics proposed above suggest that oppositional new media are as varied, volatile and technologically sophisticated as the communities that create and share them. They embody the activist, culturally eclectic, local and playful values of the longstanding progressive strain in American culture and politics, and comprise a vital and innovative response to the dominant media and political/economic environment.

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Babel in the international café: A respectful critique

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Abstract. This paper reflects on the case of participants with different first languages conversing in "The International Café" in an online workshop about Communities of Practice. It describes the context of the café within the workshop and an informal translation experiment designed to bring together community members with different first languages. In the light of this experiment the paper critically reflects on the effectiveness of translation for negotiating meaning in international community conversations. It discusses the value of cultivating global literacies where language is considered not as a technical issue requiring translation equivalence, but as something that shapes individual and collective worldviews, where the fine-tuning and exploration of situated meanings of people with different first languages is viewed as integral to the process of interacting, learning and sharing knowledge in an international community. The reflections highlight a connected issue of time: for participating in, facilitating and designing for such conversations. Finally, international conversations in the café are contextualised as part of a broader issue of clarifying the purpose and principles behind cultivating a truly international online community workshop. Four key issues arising from this reflective critique are tentatively offered as inter-connected design factors for international online community environments.

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Introduction

> Every time the question of language surfaces, in one way or another, it means that a series of other problems are coming to the fore. (Antonio Gramsci, 1935)

Online communities are increasingly international in character. The synergies of people with locally situated knowledge from different national cultural contexts offer substantial and creative opportunities to inform and shape the processes of knowledge creation and learning in international communities. However, if we take the view that situated knowledge is embedded in language, then a question arises about what we could be losing in an international, multilingual community that is negotiating and sharing meaning only in one language.

This paper studies a small but significant informal experiment where participants in the café of a community workshop "spoke" in their first language, and where the posting was quickly translated into three other languages of fellow participants. Such an experience might have been expected to result in the encompassing and extending of different worldviews and different local knowledge. However, a reflection on the process of this experience does not necessarily lead us to conclude that it did. Rather, it leads us to consider that while negotiating meaning in unilingual groups is already a complex issue, further complicated by the challenges of communicating online, the complexity of meaning-making is significantly amplified in a dispersed community with members conversing in different national languages.

The paper begins by describing this international café experiment in the context of the online workshop, then discusses the limitations of translation as a means of negotiating meaning, and finally goes on to explore some of the connected issues that arose from the experience.

Methodology

Data was collected in the form of semi-structured reflections from members of the café organising group and from café participants, followed by respondent validation. This informal experiment is offered as a retrospective reflection as it was not set up as a research inquiry from the start. Only after the event had taken place was it decided that the experience merited a deeper reflection and analysis. Data collection was thus limited to those participants who responded to an invitation to collaborate in the reflection one month after the end of the community workshop. Throughout this paper the words of participants and organisers of the café are represented in italics, indented and identified with a

person's initials, illustrating the different voices of the collaborators in the reflection. The initials of participants who completed their reflections anonymously are indicated by XX.

The café in context

The location of the café was at a space in WebCrossing during a seven-week workshop on Foundations of Communities of Practice (CoP) offered by CPSquare. The workshop, the tenth since its inception, has as its principle market people from the business community, and over the years has seen an increasing number of participants from outside the US from English and non-English speaking countries. Activities such as the "six degrees of separation" (based on the premise that everyone in the world can be linked to any other person by six other people or less) whereby participants discover how closely they are connected with a group of fellow participants have helped enrich the character of international relationships in the workshop. The process of internationalisation continues to be an important concern for the workshop organisers.

Last year, for the first time, a parallel workshop in Dutch was carried out during the same weeks as the main, English language, workshop. The organisers of this workshop planned and independently ran a workshop, adapting the main workshop's content and activities to their local context and market. The connecting space between the Dutch and the main parallel workshop was based on the metaphor of an international café, where it was expected that people from both workshops could come together and socialise in a relaxed, informal environment. This model is being extended later this year for a third parallel workshop to take place in Italian, where the café will be the bridge between the three different workshops.

This year, in the spirit of innovation characterising the workshop, the informal translation experiment took place with every message being translated into three other languages ("signed" by the translator). Everyone would post their message in their first language. The message was then translated (sometimes by the writers themselves) into Dutch, English, French and Spanish. The translation should take place as soon as possible after the original message was posted. The following two screen shots gives an indication of the welcome to participants as they entered the international café and the way in which a message appeared in the four languages:

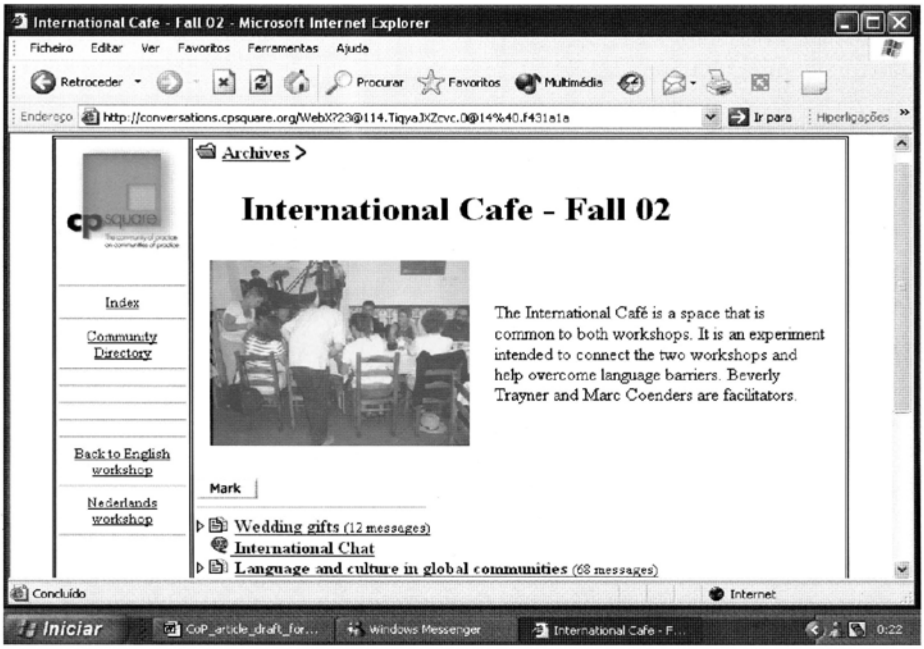

Figure 1: The Welcome message in the international café

Figure 2: A message in four languages

Responsibility for doing the translations was voluntary, although the members of the organising team were strongly encouraged to take it on. Of the sixty eight messages in the café:

- All were translated into at least two other languages.
- Eight messages were not translated into three other languages..
- Seventeen messages were posted in two languages by their author.
- Three messages (from two people) were posted in three languages by their author.
- Three messages were written in English (as a second language) and translated back into the author's first language.
- Two messages were only posted in one language by (English) bi-lingual authors.
- Four individuals voluntarily did approximately forty-five of the translations.

At the end of the café the interactions that took place were summarised by an organising team member who attempted to draw together the main themes of the messages. These themes were:

(1) Traduttori, traditori (the translator, a traitor)?
(2) Use of English as an international language.
(3) Language and culture.
(4) Questions and issues raised.

Although the summary of the international café was written in English, the words of participants were woven into the text in the original language of their posting.

Searching for a translation equivalence or *le génie de la langue*[1]?

I was surprised at how difficult it was to translate. (JS, 2003)

It is not uncommon for people to view translation as merely a "technical" exercise that involves searching for a linguistic equivalent to particular words and phrases. As in our experiment in the international café, translation is seen as a useful instrument for overcoming language barriers and helping to connect people with different first languages.

However, translation equivalence is more complicated than it may at first appear. Sechrest et al (cited in Usunier, 1998:49-50) identify four different translation equivalences:

(1) exical equivalence (dictionary translation);
(2) idiomatic equivalence;
(3) grammatical-syntactical equivalence (particularly word order); *and*

---

[1] The *spirit* of the language.

(4) experiential equivalence, or what words and sentences mean for people in their everyday experiences.

Whereas the efforts at translation in the café may have helped to express lexical and grammatical-syntactical equivalence and, to some extent, idiomatic equivalence, the work of translating *experiential equivalence* would have been out of the realms of the translators' remit. Yet it is precisely this experiential equivalence that we could imagine an emerging international community would want and need to explore in their conversations.

An even stronger criticism of translation in the international café would have come from Sapir and Whorf, two influential linguists at the beginning of the 20th century, whose argument was based on the premise that language shapes individual and collective worldviews (rather than being shaped by them). Furthermore, those mental maps and structures that correspond to our worldview, our *Weltanschauung*, are determined by the way language creates categories in our minds, directly influencing our construction of reality. Sapir states in a widely cited passage: "No two languages are ever sufficiently similar as to be considered as representing the same social reality. The worlds in which different societies live are distinct worlds, not merely the same world with different labels attached." (Sapir, 1929:214)

Thus, a Sapir-Whorf perspective would hold that translation is at the very least problematic, if not impossible, especially if our goal is to understand meaning as embedded in different worldviews. Translation is deceptive, giving the idea that the "other" is engaged in the same activity as we are – only in a different language. While this view may be underestimating the helpfulness of a good translation, it does remind us of the possible reductionism of viewing international communication as dependent on translated texts. All the more so if we hold that meaning does not reside in the text itself, but rather in the *interpretation* of the text, which in turn is influenced by the socio-cultural context in which the text is both written and read.

This brings us briefly to an aspect of current social semiotic theory, which takes the perspective that language is a system of meaning that is created by a culture (where culture is a social system). Hence, trying to understand the meaning of someone's words *in their cultural context* is important for understanding a person's way of seeing, thinking and acting. Fairclough, writing on semiotic aspects of learning, refers to text (written and spoken) as a social event (2003:2). He refers to what people learn *in* and *through* texts and talk as "texturing" (ibid.:5). Furthermore, he claims that what people learn "in and through the process of texturing … is not merely (new) ways of texturing, but also new ways of acting, relating, being and intervening in the material world" (ibid.). Relating this to the issue of translating in the international café, we might reflect on how translating, rather than texturing, may in fact be ignoring the need

to try and understand the cultural context in which the language is situated, and thus missing an opportunity to learn through it. An interesting reflection by one of the Dutch members of the organising team shows a growing realisation of the complexity of translating and of possible over-simplification in reading translated texts. These emerging insights would have been lost on the majority of people who were only reading the finished translation, rather than being involved in the co-construction of its meaning:

> I thought firstly that the job I was doing (translating) was just an extra task that had to be done. While translating I became suddenly aware that I was reading the messages differently ... I was reading them more closely. The insight for me was that in the international discussions I should be more aware of my reading style. (MC, organising team member, 2003)

Likewise, a reflection from a Spanish speaking participant/translator:

> Translating postings, especially others', demanded a greater attention to what people were writing. (PN, workshop participant, 2003)

A pragmatist like Usunier, a researcher of cross-cultural management, warns that even a good translation offers only an illusion of sharing in the same vision of reality. His advice could usefully be adapted in many cross-cultural settings. He proposes that, where possible, words should be kept in their original form to recognise the culturally unique concepts represented by the language. He advocates "linguistic polycentrism", offering three practical ways to encourage this, by:

(1) trying to keep words in their original language, where possible (as we did in the summary document of the international café);
(2) understanding meaningful elements in the grammar (such as gender, tense, sentence construction); and
(3) trying to behave as 'explorers' of the meanings and worldviews expressed by different languages. (1998:59)

The role of participants as explorer will be picked up later in the paper, but first we should consider the nature and purpose of online conversations, particularly in relation to multilingual context of the international café.

Cultivating International Online Conversations

An important question arises about whether or not translating messages facilitates the type of conversations we would like to be cultivating in the international café. Over several years Sherry (2000) has been writing about the nature and purpose of different types of online conversation. Drawing on the work of Jenlink and Carr (1996), she indicates a taxonomy of online conversations: dialectic,

discussion, dialogue and design. If we look at each of these types of conversation we may conclude that translation may be more appropriate for certain types of conversation in an international café than for others.

Dialectic conversation focuses on framing a logical argument for expressing the truth where "(t)he nature of the dialectic conversation is one of debate and logical argument within a context of limited negotiations for change" (Sherry 2000:5) We could imagine a good translation being helpful in these conversations for presenting clearly articulated arguments from all sides of the debate.

Discussion conversation is a forum for people to advocate their own individual point of view. It is different from dialectic in that it is more influenced by personal opinion and supposition and where the conversations "are transactional in nature" (ibid.). Translation may be more difficult in this type of conversation given the subjective and evolving nature of people's positions in a discussion.

Dialogue conversation is where meaning is constructed through sharing and negotiating. It is "a community-building form of conversation" and "its purpose is to create a setting where conscious collective mindfulness can be maintained" (ibid.). Sherry also relates dialogue conversation to Bereiter's concept of "progressive discourse" which involves "creating commonly shared meanings and constructing a shared purpose" (2000:6).

In a dialogue conversation we might question how effective it really is to have translations of conversation members' interactions for jointly constructing meaning. Rather, careful consideration by the conversation members (not just consideration by the translators, which is what happened in the café) of the meaning and interpretation of their own and other's words (and worlds) would be an important aspect of taking on a "conscious collective mindfulness". The role of conversation members would be more as 'explorers' of the meanings and worldviews expressed in different languages (suggested by Usunier), rather than merely responding to postings of translated points of view.

Design conversation is goal related and concerned with creating something new. There is a close relationship between dialogue and design conversations except that design conversation "goes beyond the suspension of personal opinions and moves into a suspension of mindsets themselves" (ibid.:6). A design conversation involves "shifts in the very ground on which they stand, transforming and expanding their sense of self, and deepening their capacity to hear and inquire into perspectives vastly different from their own." (ibid.) This combination of tangible outcome and a shift in mindsets suggests an expansion of both tacit and explicit knowledge of conversation participants.

In short, *texturing* in a design conversation deepens an individual's capacity to listen and explore perspectives that are very different from their own and, through the process of creating something new, is capable of transforming a person's *Weltanschauung*. It follows from this that a design conversation requires an

understanding of the socio-cultural elements of communication of meaning, which goes well beyond mere technical competences of translation.

The potential depth of a dialogue conversation and the transformative value of a design conversation would clearly be at odds with short, easily translatable postings. However, quite early on in the international café the most active translator and organising team member pleaded to:

> **Keep our entries short**
>
> Since we are trying to translate everything, we should try to keep our posting reasonably short so that translators will not give up. (EW, 2003)

Indeed, if we look at the number of threads and messages posted in the main café discussion area, and if we assume that discussion, dialogic or design conversations would tend to generate a greater number of postings in any one thread rather than many single postings, we can get an impression of the types of conversations that might have taken place. Therefore, if we categorise the café conversation threads under the headings of: single posting, posting plus comment, posting plus two or three comments, posting plus more than three follow-up postings, these are the type of conversations that took place:

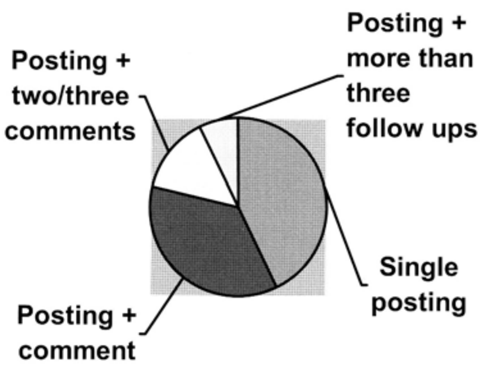

Figure 3: Indication of the types of conversations in the international café

In other words, just under 80% of the conversations were either single posting or single posting plus comment. While a closer analysis of the content of the messages, as well as a comparison with the pattern of conversations in both the main workshop and other similar types of online workshops would be helpful in interpreting these figures, this record does not suggest that translations in the café actually encouraged international community building (dialogue) or design conversations. In fact one of the most active participants in the café summed up his involvement as:

I was involved, but had the feeling that I was sending messages in a bottle. (MD, 2003)

It is interesting to note that those threads where discussion or dialogue did take place were entitled "Language", "El mismo idioma, differente culturas2" and "El traductor3" all of which explored the nuances of language, culture and translating.

To summarise, we need to be clear about the purpose and intent of the conversations when considering the usefulness of translations. Translations, which are very demanding, may be more helpful in dialectic conversations and possibly (although by no means certainly) in discussion. However, as discussion conversations are not for finding solutions or constructing new knowledge we may want to move the conversations further in our international café. Dialogue, or community building, conversation which focuses on constructing meaning through sharing perspectives, but which does not have a goal or an intended outcome, may be an appropriate type of conversation to aim for (given the metaphor of a café) but for which translation would be unhelpful. Design conversations are arguably ambitious given the time people have to participate in the café and the amount of work required in the main workshop. However, given that design conversations are goal related and focus on creating something new, they may also be seen to suit the purpose of a certain type of café. For example, we can imagine the Parisian café in the 60's that provided a location for intellectuals to be active in the philosophical and political debates of that time, and the Portuguese *Tertúlia* before the revolution in 1974, where café-talk ranged from exploring the artistic and cultural to articulating and planning underground, political ideas.

It might be helpful at this stage to ground these reflections about types of conversation in the light of a suggestion made by one of the organising team members:

Suggestion:

(...) make a language learning space for instance – build a dictionary or glossary of CoP terms in multiple languages. (BS, 2003)

With this suggestion it is possible to imagine participants with different first languages jointly building a dictionary or glossary (or a *distinctionary*) of CoP terms in different languages, with their roles and relationships being those of co-explorers of multi-languages, involved in design conversations that lead both to negotiating meanings and discovering what words signify in each other's socio-cultural contexts. In validating this paper, a participant gave an example of how

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[2] The same language, different cultures

[3] The translator

[4] See the work of Work Frontiers International: http://www.workfrontiers.com/distinctionary.html

this might work. He referred to the word community, which might well be translated technically into Spanish as "comunidade":

> In Argentina, people talk about "comunidades" as synonymous of neighbourhoods, mostly poor neighbourhoods, while "la red" is something very similar to a CoP within the neighbourhood that does something specific, such as support children in learning reading and writing, collaborate in the neighbourhood free dining facilities, etc. It also makes me thing about specific and local cases. (PN, 2003)

Going back to social semiotics, what people would be learning through texturing, i.e. in and through their conversation about CoP terms in multiple languages, would lead to new ways of seeing, acting, relating, being and intervening. Laudable objectives for an international café of explorers!

Prioritising time

Such laudable objectives are all very well, but they involve a significant investment of time. Time, or lack of time, was a thread running through almost all reflections about the café from both participants and café organisers. Not only was the act of translating a lengthy business, with translators all reflecting similarly that what surprised them about the café experience was "*how time consuming it was to translate*" (MD, 2003), but also time was a general issue that arose about participation in the café but which were also reflected in comments about the workshop. These feelings are illustrated both in comments like "*if I had had more time*" (MR) and "*I didn't have time to participate as much as I'd like to*" (XX) to the fact that around two thirds of workshop participants did not post anything at all in the café. Moreover any change in the design of the space, the objectives or the activities of the café would require more time: time for designing and setting up the space; time for facilitating; and time for participants to engage in and reflect on meaningful conversations. Hence this issue of time and translation cannot be disentangled from any aspect of an international café and clearly the price levied in terms of time in an international café is one that has to marry with the cafés objectives and its role in the CoP workshop.

Multiliteracies: a proposal

If the answer for the international café is not "simultaneous" translation from and to participants' first language, then where do we go from here?

A suggestion would be to move in the direction of explicitly valuing, encouraging and reflecting on **global literacies**. In simple terms, global literacy is "a state of seeing, thinking, acting and mobilizing in culturally mindful ways" (Rosen, 2000:57).

However, it is particularly useful to look at global literacies as an aspect of multiliteracies defined by The New London Group in their article "A Pedagogy of Multiliteracies" first published by Harvard Education Press in 1996. Some of the theory behind multiliteracies could be extended to practical suggestions for the international café.

The multiliteracies argument begins with the premise that our personal, public and working lives are changing in dramatic ways, and these changes are transforming our culture and the ways we communicate. The term multiliteracies stresses two important and closely related changes:

(1) the growing significance of cultural and linguistic diversity and our daily task of negotiating differences both in our local communities and in our increasingly connected working and community lives;
(2) the influence of new technologies where meaning is made in increasingly multimodal ways. "To find our way around this emerging world of meaning requires a new, multimodal literacy" (ibid.)

Following from their presentation of the need to master multiliteracies, the New London Group introduces the notion of a pedagogy based on design where "(t)eachers and managers are seen as designers of learning processes and environments." (2000:19) They propose a meta-language of meaning-making based on the concept of design in three phases:

(1) **The Designed**: accessing existing resources of available designs, or the available patterns and conventions of meaning (*situated practice*);
(2) **The Designing**: a process of shaping emergent meaning which involves re-presentation and recontextualisation (*critical framing*);
(3) **The Redesigned**: an outcome of designing something through which the meaning-maker(s) have remade themselves or a new meaning-making resource (*transformed practice*). (ibid.:20-23)

Returning to the suggestion put forward earlier by one of the organising team members, let us look at how a mulitliteracies approach could work in practice. The suggestion was to *build* a *dictionary or glossary* of *CoP terms* in *multiple languages*:

Multiliteracy phase	Suggestion	Multiliteracies approach
The Designed	"CoP terms"	Accessing existing CoP terms and concepts (in English)
The Redesigning	" ... build ..."	Finding local meanings for CoP terms, by describing and comparing what they mean in different languages and in local contexts.
The Redesigned	"... a dictionary or glossary... in multiple languages"	Production of a multimodal, multilingual glossary with an indication of what the terms mean in different local contexts.

Relating this suggestion to some of the concepts developed by Wenger (1998), we could regard the co-constructing of a glossary as participation and reification, where participation "refers to a process of taking part and also to the relations with others that reflect this process" (Wenger, 1998:55) and reification as "the process of giving form to our experience by producing objects that congeal this experience into 'thingness.'" (ibid: 58). The process of building a multi-contextual and multimodal glossary would resonate with Wenger's description of the negotiation of meaning which "involves the interaction of two constituent processes, which I will call participation and reification" (ibid:52) The glossary would not represent a simple product of translation, but rather a joint reflection on situated practices and contextualised meanings. As Wenger states: "the products of reification are not simply, concrete, material objects. Rather they are reflections of these practices, tokens of vast expanses of human meaning." (ibid: 61)

Discussion

There are three questions arising from this suggestion about a multilingual CoP glossary. The first question is in what language would conversations about it take place? The second is how, or in which modes, would the different languages/contexts be represented? And the third is to what extent is a café the location for carrying out even a minimally designed task?

(i) The question of language

First let us look at this question of language. A café participant reflected on the fact that the person in the workshop whose linguistic level of English was fairly weak insisted on writing his messages in English and translating them back into Spanish. He pointed out:

> If there are no national or language subgroups ... for which talking in that language is a way of relating and negotiating a specific kind of knowledge that otherwise is not available, then there is little sense for someone to talk in their own language. (PN, 2003)

Another view came from a Dutch participant who, on first entering the café, was reluctant either to speak in Dutch or to translate her messages. She said that she was so accustomed to talking in communicating in English that she saw no reason to speak in Dutch.

An active participant/translator (whose first language is French) in the international café went even further:

> I would limit the concept of international café for highly specific domains of knowledge which are only cultivated by a relatively small community of highly educated people who prefer to write in some languages but can read a lot more. Make sure that the domain of knowledge addressed is very specific so that participants understand why the café is international. Do not spend time translating. Just provide a link to an online translator to help readers who are facing a tough challenge. (MD, 2003)

While screening access to the café may not be in the spirit of the workshop, this observation provokes some thoughts about global literacies. Taking a global literacy approach would explicitly value an individual's linguistic and cultural capital, particularly if it was multilingual and cross-cultural. English would be used as the international language, with task(s) that encouraged the use and discussion of words and concepts in different languages while at the same time being mindfully observant about how fellow participants were using and weaving between languages to participate in an international dialogic or design conversation. In the example of a multilingual glossary, participants speaking the same language or even languages of the same origin would probably discuss the meanings in context in their first language. A Spanish-speaking participant with a substantial amount of experience of working in international communities made a relevant comment in one of his suggestions for the café:

> I would attempt to present the discussion as separate, single language threads. So a Frenchman would see it running completely in French, a Spaniard in Spanish etc. Maybe a link could go back to the original in the original language, for those who can and want to check the original wording. It might end up having less of an International flavour, but be better at promoting participation. (BS, 2003)

Another related suggestion was made to "have a phone call – one for each language to discuss it" (JS, 2003) with "it" referring to the café but which could refer in this case to discussing both the task and the interactions. During this process monolinguists would be encouraged to develop strategies for observing, using and developing a greater repertoire of multiliteracies, particularly through observing the strategies of multilinguists.

Such a process was in fact hinted at by a monolingual participant in the café who expressed his surprise at how

> the focus on differences between languages turned itself in, to become a focus on the way I use my own language and on shades of meaning within the English tongue. (PR, 2003)

In short, the values behind a multiliteracy approach would reflect and extend the sentiment behind the café translation experiment in attempting to avoid the taken-for-granted assumptions of 'rightness' inherent in a monolingual and monocultural *Weltanschauung*. In other words:

> Unilingualism fits comfortably with, and gives credence to, ideas of naturalness and inevitability of worldview. These can be made vulnerable only through the study of other languages and the interruption of the naturalness to which each predisposes its users. As the largest signifying system and set of practices available to humans languages represent the embodiment of pluralist alternatives. (Bianco, 2000:100)

(ii) Representing the glossary

While this paper does not intend to explore multimodal ways of representing a multilingual glossary, it does put forward a suggestion by Nancy White[5] (personal communication) to reinforce the multimodal aspect of designing for multiliteracies. For presenting the final outcome, White proposes adding:

> a technological tool, that, when a person enters any of those terms in a post box, there is a function that allows the reader to access the translated, shared meaning terms (2003).

The original suggestion of building a dictionary or glossary of CoP terms has now been framed as a multiliterate project aiming to bring people together to explore and negotiate local contextualised meanings, which they will present in a multimodal form of reification.

Be that as it may, it now looks as though the relaxing sofa in the café has been turned into a busy work place, reminding us of the ongoing issues of time and of purpose and leading us to reflect in more depth about the purpose of the café.

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[5] Nancy White, Full Circle Associates, http://www.fullcirc.com/

(iii) Clarifying Purpose and Principles

While some organising team and participant reflections suggested that the café should have a clearer purpose and/or tasks, others liked the metaphor of the café and advised against detailed planning or active facilitation. Such a debate lends itself to clarifying the overall purpose and intention of having a café in the workshop. To what extent was the international café a comfortable (except perhaps for the translators) social add-on to the workshop? Or to what extent is the café a place for meaningful international and local learning synergies and transformation? What precisely does it mean to be "a link" between workshops? In the words of one of the organising team members:

> I think we need to give this café a more clearer place within/between the workshops. We have to think more about the purpose and what it could offer the participants ... I think the name is not right ... The thing is that the workshop itself can already be international. (MdL, 2003)

His thoughts were echoed in many participant reflections, such as this one:

> The launch and what we really wanted to achieve never was very clear in my mind. (MD, 2003)

This may also help account for the fact that very few participants from the Dutch workshop made any contribution to this café space that was specifically set up to be a link between them and participants of the main workshop. However, as pointed out by one of the organising team members this lack of participation in the café also raises a doubt about the role of translation as a *bridge* between workshops.

> My first thought on this is that their desire to speak in their native tongue was satisfied by the wholly Dutch workshop while those (non-native English speakers) in the English version might have needed this more. (BS, 2003)

Perhaps it would be helpful at this stage to contextualise this reflection on the international café as just one part of the process already underway of internationalising the workshop as a whole. Internationalising in this case refers both to recruiting participants from a wider international market and to opening the community network to people with different national perspectives and backgrounds. Jane Knight (1997), a leading writer of internationalisation in Higher Education may have some transferable insights here. She is very clear on the point of transformation of an organisation as a goal of internationalisation and talks of **integration** as a key:

> First, there is the integration of the international and/or intercultural perspective; Secondly, integration refers to the coordination of the various international activities to ensure that... there is a mutually beneficial relationship amongst initiatives... Finally, the international dimension needs to be integrated into the mission statement, policies, planning and quality review systems. (cited in Callan,1998:50)

From the business world, in an interview with Dee Hock, the founder of Visa International, we also hear about the importance of transformation. His vision of "transformation by design" does not refer specifically to either becoming international or to community building, but his words complement those of Jane Knight. In the interview, Hock states that:

> Your organization needs to be absolutely clear about purpose and principles and must be very careful to know what a purpose and a principle is – you know, a purpose is not an objective, it's not a mission statement – a purpose is an unambiguous expression of that which people jointly wish to become. And a principle is not a platitude – it is a fundamental belief about how you intend to conduct yourself in pursuit of that purpose. You have to get very precise about these things. http://ww.wie.org/j22/hockintro.asp

While the issue of translating into three other languages in the international café may have begun as an experiment in removing language barriers, perhaps it is also the beginning of a process of making explicit to all stakeholders the purpose and principles behind a truly international, online workshop on Communities of Practice.

Conclusion

This in depth reflection on a brief informal experience of international communication in an online community workshop has attempted to highlight a number of interrelated issues. These issues or threads could provide the weft and the warp of a design for an international online community environment where negotiation of meaning and meaning making between people with different situated practices from different cultural contexts represented by different first languages is acknowledged and valued. Running vertically would be considerations in designing for different types of online conversations and designing for multiliteracies, while running horizontally would be considerations relating to clarity and integration of the purpose and principles of international actions[6] as well as of the time required for design, facilitation and participation.

In reviewing these considerations one might pause to reflect if they only apply to communicating and negotiating meaning in multilingual environments or if

[6] Technological or practical considerations, such as the character set available in the software, or consideration of international time zones were not in the scope of the paper.

they are not also pertinent to unilingual ones. Indeed we are reminded of Bakhtin's claim that all communication is, in a sense, translation. (Brandist, 1985) Certainly, communication in an online learning environment is already a complex issue, with language (and the *Weltanschauungen* that language represents) serving to greatly multiply the levels of complexity in the dynamics of meaning-making and negotiation of meaning. As Nancy White points out, in the online environment

> we can often walk away thinking we share meaning but don't. Add language to that and you have a fine pot of stew. (personal communication, 2003)

As the number of international communities grows, in what is now frequently referred to as a global knowledge-based society, further research is required to identify the role of international online communities in exploring and negotiating meaning and for challenging the taken-for granted assumptions behind a unilingual *Weltanschauung*. A closer examination needs to be made of the processes at play in the critical framing of both local and international (situated) knowledge, their transformation into new local and international practice(s) and the roles of languages, communities and technologies in these processes.

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Synchronizing Asynchronous Collaborative Learners

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Abstract. This paper addresses the issue of different levels of progress in asynchronous collaborative learning activities. The context for this research is organizations of distributed and mobile practitioners. When introducing collaborative learning parallel to daily work tasks we cannot assume that all participants have the same possibility to actively engage. Therefore the learners can be at different levels of progress in the collaborative learning activity. To facilitate collaborative activity the progress of the participants has to be synchronized in some way. The main problem addressed in this paper is the difficulty for participants to keep a common progress, to enable discussions, in asynchronous collaborative learning. To address this problem three methods for synchronization (synchronization points) are suggested: *locked scenes*, *written instruction* and *collaborative production*. The three methods were implemented and evaluated in an organization using a Net-scenario, the Net-scenario as a system and a methodology based on role-playing to initiate collaborative learning. This system was suitable to use in the evaluation since it can be used asynchronously as well as synchronously, supports distributed participants and is dependent on collaborative discussion concerning the content presented.

Introduction

The use of IT to support learning activities is widely adopted. The focus has traditionally been on making courses available for distributed students and using the computer individually and collaboratively in the classroom (e.g. Laurillard, 1993; Leidner & Jarvenpaa, 1995), thereby taking a school perspective on learning. However, "Learning can no longer be dichotomized into a place and a time to acquire knowledge (school) and a place and a time to apply knowledge (the workplace)." (Fisher, 2000).

M. Huysman et al. (eds.), Communities and Technologies, 427-443.

Wenger (1998) describes learning as dependent on collaboration in communities of practice. Further on social participation is a process of learning and knowing which includes four interconnected and mutually defining components; meaning (learning as experience), practice (learning as doing), community (learning as belonging) and identity (learning as becoming). These four components depend on collaborative activities. Social processes are essential in learning, shaping our identities and what we do as well as what we know (Berger & Luckman, 1966). However, in distributed work the engagement in social processes with colleagues becomes problematic.

Knowledge workers, defined by Drucker (1959) as workers using knowledge as their main tool, learn continuously and their work often tend to take on a mobile character thus requiring flexible and mobile systems supporting learning.

The context for this research is organizations of distributed and mobile practitioners who can be seen as knowledge workers, using Drucker's definition.

Collaborative learning activities that take place parallel to daily work tasks must be handled and understood differently than learning activities introduced within a school setting. In school the students' main task is participating in (or at least attend) various learning activities. When introducing computer supported collaborative learning as a concurrent activity to daily work tasks we cannot assume that all participants have the same possibilities to take part in the activities due to, for example, differences in their daily workload. This means that participants can be at different levels of progress (concerning what tasks and content each of them has been introduced to) in the learning activity. In collaborative learning this is problematic because participants who are not synchronized are introduced to different tasks and different content. This decreases the possibility for collaborative activities concerning the issues presented. To enable group discussions concerning a certain issue, the task and content has to be known and current to the whole group at the time of the discussion. The participants have to be presented to new tasks as a group to make the activity collaborative and to enable discussions. This means that the group has to collaboratively progress through the learning activity. To support this, three methods (synchronization points) is introduced in this paper.

To be able to evaluate the three synchronization points with mobile and distributed practitioners engaged in collaborative learning the Net-Scenario (Lundin & Nulden, 2003) was used. The Net-scenario applies collaborative role-playing based on a multimedia enhanced story as the structuring activity. The Net-Scenario is mediated and supports asynchronous use, technologically and methodologically, and are thereby adjusted to the context of distributed participants. In this paper the term scenario is used as the story in the Net-scenario around which role-playing is organized.

This paper describes methods that have to be provided to create a possibility for vivid and structured discussions in computer supported distributed and asynchronous collaborative learning. The main problem addressed in this paper is the difficulty for participants to keep a common progress to enable collaboration in computer supported collaborative learning activities.

The research question addressed in this paper is:

How can computer support for synchronization in collaborative and asynchronous learning activities be designed?

In collaborative learning the discussions among the participants are essential. When collaborative learners are distributed, tools for mediating these discussions are needed. This means tools for synchronous communication such as text chat, voice or video chat, as well as tools for asynchronous communication, such as text forums, video recordings or e-mails. The effects that these mediums have on the communication in distributed groups will not be further elaborated in this paper. The area of communication in collaborative systems has been extensively examined in research (e.g. Ehrlich 1987; Ellis *et al.* 1991; Orlikowski 1992).

Following this introduction is a presentation of the Net-scenario. In the next section the methods for synchronizing is described. Then a description of the system deployment and the research method is given. This is followed by the results and the analysis. Finally a discussion and the conclusions are presented.

The Net-Scenario

The Net-scenario is based on a stationary learning activity; the Multimedia Scenarios, which was designed to initiate a collaborative learning process structured around a set issue. It is based on a multimedia-enhanced story, which structures and supports collaborative role-playing as a learning activity.

In the Multimedia Scenario a group of five to eight participants are engaged in role-playing. The basic setting is a group of participants gathered around a table, following the scenario on a big screen and aided by a facilitator. During this time the participants experience a problematic situation presented in the scenario. The Multimedia Scenario was first implemented in undergraduate education (Nulden & Scheepers, 1998). It also proved its potential in primary school education (Nulden & Ward, 2002). The transfer into workplace learning was made with successful results (Hardless *et al.* 2001).

Role-plays can be described as dramas in which a number of participants are asked to portray a particular character, but no lines are provided, as for actors (Steinert 1993). The purpose of the role-play in the Multimedia Scenarios is to initiate reflection and discussions on issues directly related to a group of professionals. Role-playing in Multimedia Scenarios is based around a story, which is constructed of acts that each consists of a number of scenes. Each scenario focus on a main issue, each act brings up different aspects of that issue and each scene in the acts gives different background information contextualizing that aspect. The group is guided through the scenario and is, at certain points, encouraged to interact as a group, with the scenario.

However, the Multimedia scenario is designed for use in a stationary setting and is therefore not suitable for continuous learning parallel to mobile and

distributed work. This is the reason for the development of the Net-scenario. The Net-scenario is web based and can be accessed from the users' laptops as long as they have internet access. Each scene is represented by a web page that gives the participants information relevant to the current act. It is constructed using a server for the multimedia files. The system keeps track of the group's activities to make sure that, at each new use-session the scenario would continue in the same place as where the participant was in the scenario when they logged out. This way the system keeps track of each participant's progress in the story. It was not possible to move to previous scenes in the scenario. It was also important that the system kept track of the progress to maintain a low effort to facilitate fragmented participation in the Net-scenario.

Synchronizing collaborative learners

Using distributed collaborative learning introduces challenges when the participants are not only dispersed in space, but also in time. Given that the participants will access the online activities in an asynchronous manner they will soon end up at different levels of progress. Since the goal is collaborative learning, this creates a problem. To be able to have vivid discussions concerning the content and tasks presented all participants have to be introduced to the same content prior to the discussion. Different levels of progress would mean that different things would be relevant for discussion. Thus it is important that the asynchronous use in some sense is synchronized.

This could be solved by giving the participants deadlines that tells them how far they are expected to have reached at a certain time. However, the use of deadlines has two main disadvantages. Firstly, if forcing the participants to reach a deadline they are less likely to feel in control of the progress and to feel responsible for the outcome. Secondly, in collaborative learning that is used parallel to daily work tasks, the idea is that the participants themselves should decide when, where and to what extent they are to engage in the role-play. A deadline would make this impossible.

To address the problem of users scattered in the online activity a method for synchronizing the participants' progress was developed: synchronization points. The purpose of these is to bring the group together to make the discussions, the basis for the collaborative learning, possible. The function of the synchronization points in the Net-scenario is shown in figure 1.

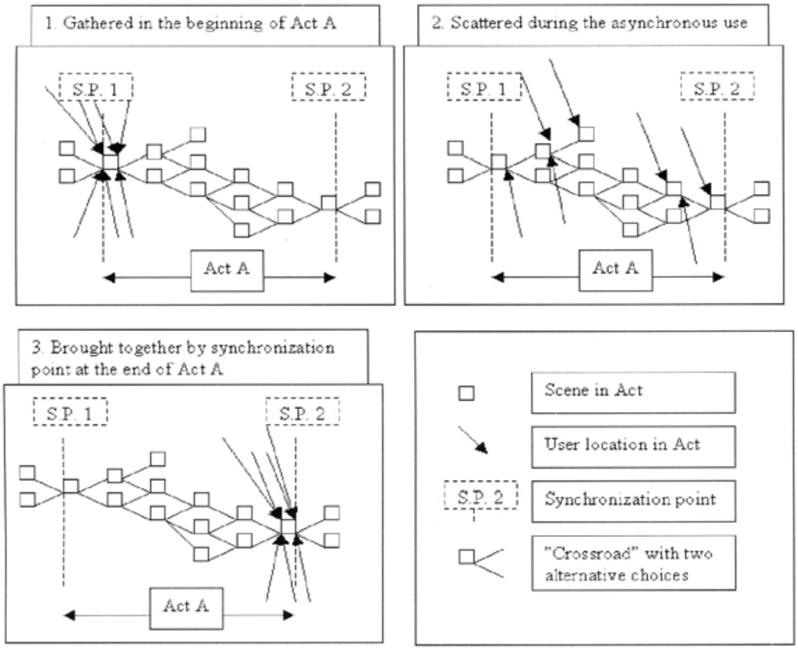

Figure 1: The function of the synchronization points in the Net-scenario

Three different synchronization points were developed to guide the participants' progress in the Net-scenario.

- Locked scenes

By controlling the information available, the users are held together in the same part of the learning activity to stimulate discussions. In the Net-scenario this is implemented by, at the decision crossroads, all participants have to agree before the group could continue, meaning that the system will not let them continue until an agreement is reached.

When the first participant reaches the *locked scene* she is encouraged to remind the others to proceed in the Net-scenario. This is done by making the participants' progress visible at the locked scene. Next to each participant name the system provides direct links for prompted e-mail and creating text message delivered to the specific participant's cell-phone. The aim of this is to motivate the other participants to be more active. The possibility to remind participants is available until everyone reaches the *locked scene*, then the continuation of the Net-scenario is unlocked. This way all participants who are gathered at the end of the act have a common responsibility to engage the other participants.

- Providing written instructions

This is done by instructing the group to make sure that all participants are gathered before continuing. It is implemented by providing an instructional text at a set scene in the Net-scenario, the text instructs the participants to work with a

given task as a group and to reach a unanimous decision before they continue. With this synchronization point it is possible for the group to oppose to the instruction, *i.e.* proceed without all participants, the system has no control of this.

- Collaborative production

This type of synchronization is done by instructing the group to produce something collaboratively. The group is given a certain task to work with, the outcome can be of various types (for example a written document) and the organization of the work is left up to the participants. The progress can at this point either be locked (by using *locked scenes*) or by providing the group with a *written instruction* saying that they cannot continue until they have completed the task.

No claim is made that these three methods are in any way revolutionary. To stop the progress of a groups work until certain tasks is completed (as in locking scenes) has been used previously as a tool for organizing collaborative work. Abbot and Sarin (1994) describe the use from a workflow management perspective; when a task is approved as completed this will unlock the next task in the process. To instruct learners concerning the organization of work and to give tasks, such as *collaborative production*, are generally parts of collaborative learning. Systems supporting this are frequent in the computer supported collaborative learning area (e.g. Kienle & Herrmann, 2003). However, in this case the functions are used specifically to support a group of learners' collaborative progress in a learning activity. It is argued in this paper that this is particularly important in learning parallel to work, when the participation in the collaborative learning is not the main activity of the participants. Hence, what are added to the previous body of research are evaluated methods for supporting the collaborative progress in asynchronous learning used in a work context.

Method

This section contains a description of the experiment site and of the actual content of the Net-Scenario deployed at this site. It also presents the research methods used in the evaluation of the synchronization points.

Evaluation setting

To be able to evaluate the use of synchronization points in asynchronous learning, we introduced the Net-scenarios in an organization where many of the employees worked in a mobile and distributed way. The net-scenario was suitable since it is dependent on the groups discussions concerning the presented content, these discussions is in turn dependent on the collaborative progress of the group.

The company where the Net-Scenario was deployed has around 300 employees who are based in one large office building. The practitioners within the organization are to a large extent distributed depending on the tasks at hand. They

use much of their day attending meetings, at conferences, visiting customers or suppliers and so on. The organization's goal with the use of the Net-Scenario was to support a learning process concerning a large organizational change. The management wanted to let the employees reflect on how the changes would affect their work and specifically encourage collaborative learning concerning customer relations. The organizations objective was also to introduce new forms of distributed and asynchronous communication in project work.

The content of the learning activity described in this paper concerns customer relations. The organization experienced that textbooks and courses could not provide the only source for their learning activities. They also experienced that knowledge concerning customer relations was not shared within the organization to a desirable extent.

The group involved in the construction of the Net-scenario consisted of four persons from the organization and one researcher. This work included constructing the actual system, identifying key issues for discussion as well as writing the actual scenario that the role-play was based upon. This group selected six people from the organization to take part in the study. Three males and three females participated. They all varied in roles in the organization as well as in experience on the job. However, they all dealt with customers regular in their work. The researcher acted as a facilitator, being present in the groups' asynchronous activities.

The duration of the evaluation was limited (for practical reasons) so that the group did not have more than 16 weeks to complete the Net-scenario (from week 36 until week 51 in 2001). However, each participant's accumulated time of using the Net-scenario was impossible to determine since it is totally dependent on the engagement and activity of the group and each individual.

Research method

The evaluation of the synchronization points is based on the online activity in the Net-scenario. In addition interviews and use diaries were collected to provide a deeper understanding of the participants' activities. The online progress was followed by examining use logs, and text forums. The participants also had access to synchronous communication channels, such as text and video chat.
Four methods for data collection were used:

- Online observations

The groups' online progress in the discussion forums was followed continuously and recorded. A researcher acted as a facilitator in the online activities. Throughout the evaluation the researcher/facilitator documented his thoughts on the online activities. In this study files from text forums are used (Silverman, 1993) in combination with other methods for analyzing the use of the synchronization points. Guribye and Wasson (2002) discuss the question of doing ethnographic studies of distributed collaborative learners. They point to the fact that users' online actions cannot be separated from the offline (or rather all-the-

time) actions. This study is based on online observations accompanied by other data collection techniques.

In the analysis, the postings in the discussion forums were read through repeatedly and instances of particular interest were highlighted. These instances were then grouped and categorized. The notes of the researcher were then brought into the process and used to gain further understanding of the categories.

- Collected use logs

The usage was logged by recording the total number of times that a user had logged into the Net-scenario. The log file also showed where users were in the Net-scenario as well as how the users acted in choice situations within the Net-scenario. The logs were used to compare the actual use and the usage reported in the log books.

- Log books

Each participant was given a log book to document their use. The log books had pre-printed fields for time of usage, place of usage, how many other people was physically present at the time of usage, what activity they engaged in and additional comments. This type of diary inspired method has been used in workplace research (Hinds & Kiesler 1995, Adler *et al.* 1998, Brown *et al.* 2000), research concerning learning (Rieman 1996), as well as in studies of mobile work (Perry *et al.* 2001). The strengths of using log books that is particularly interesting to this research are the ability to capture activities where the researcher cannot be present (Rieman 1996) and the possibility to get a picture of in what manner the participants want to portray their use. So the notes in the diaries should in no way be considered objective, but "...the sources of 'bias' are, looked at from another perspective, data in themselves." (Hammersley & Atkinson 1995, p160). The log books were also used by the participants as a memory support when they were retelling their use of the Net-scenario in the interviews.

- Semi-structured interviews subsequent to the participation

All the participants were interviewed as close as possible to their final day of use. The interview method chosen was long qualitative interview (McCracken 1988). The interviews were audio recorded and transcribed. The interviewer was equipped with an interview guide to ensure that the discussion was held in a similar order with each participant and that the areas relevant to the study are brought up in each interview.

Results

This section opens with a summary of the overall activity of the participants and then a description of the activity around the first four of the synchronization points.

The online activity is described in figure 2. The figure shows the logins reported in the log books, the postings on the text forums as well as the adjusted

number of logins. The adjusted number is the number of logins reported in the log books adjusted to the total number of logins the participants made. This is done since the individual logins of each participant were not recorded in the system. The participants reported 49% of their actual logins in the log books.

The boxes marked SP # shows where the group continued on from each synchronization point. The time between the first participant's arrival at each synchronization point and the last is various as the descriptions below will show. One of the participants did not complete the Net-scenario due to personal reasons.

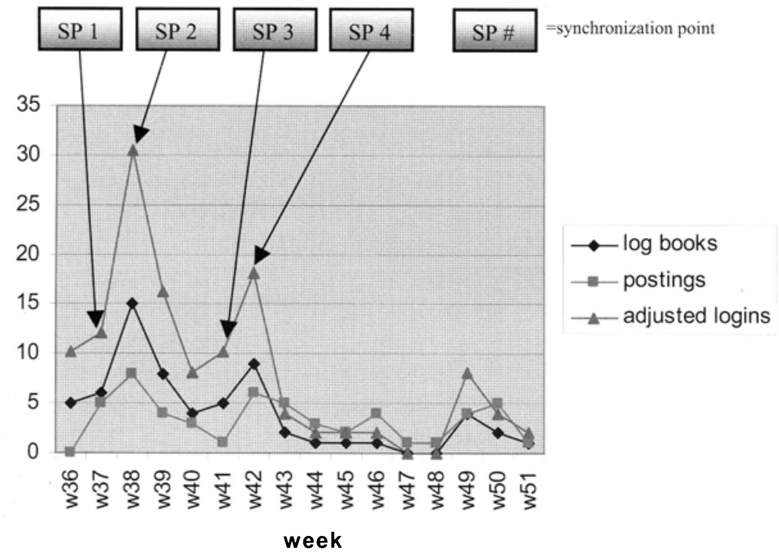

Figure 2: The synchronization points

Summary of the online activity

At the start of the Net-scenario all participants were at the same level of progress in the role-play. The activity was fairly high and the participants report in the interviews that they at this point were motivated and engaged in the activities. However, at week 38 a majority of the participants reached a synchronization point using a *locked scene* (SP 2). The group couldn't continue because one participant hadn't logged into the Net-scenario. During the time they waited for this sixth participant activity declined. However, after finally passing SP2 the active part of the group eventually regained some motivation and continued in the Net-scenario in a quite active manner. SP 3 was a *written instruction* and did not

slow the active participants down (as described below). The next drop, after week 42 (SP 4) is due to both waiting for a participant and also that one participant had to leave the Net-scenario. The activity was only rising again at the end of the evaluation period when they wanted to finish before the interviews were to be held. However, some of the participants did not finish the Net-scenario anyhow.

The activity around the synchronization points

Synchronization Point One - The first synchronization point is of the type *collaborative production*. The task in the current act in the Net-scenario concerned reflection upon experiences with customer relations and to create a document summarizing these reflections. The purpose with this first task is mainly to get the group accustomed with the system. The task inspired discussions both concerning the participants' experiences with projects as well as the organization of the production of the document. In the interviews we were also informed that the group engaged in two video mediated meetings where they discussed their experiences.

One of the participants had not logged into the Net-scenario at this point. The group created the document without the involvement of this participant.

Synchronization Point Two - The second synchronization point was of the type *locked scenes*. The group is working with a question concerning how to man the project that the scenario is based around. The participant who had not started his use at the first synchronization point, as described above, still has not logged into the Net-scenario. The active group cannot continue in the Net-scenario until he has given his opinion on how to man the project in the scenario. This waiting causes the activity to decrease. Several participants send reminders saying that they are waiting at the synchronization point, both through e-mail and through SMS. One of the participants comments on this in the interviews:

> "The group reminded him several times... I think that he had to much to do and he shouldn't have decided to join [the Net-scenario] from the start"

The other participants phone him and leave messages on his voicemail saying that they are waiting for him. The participants use the text forums to discuss how to act in the scenario. Finally the group agrees on how to proceed without the sixth participant. At the start of week 40 the continuation of the Net-scenario is manually unlocked by the facilitator even though one participant has not reached the synchronization point. The participant who did not log in comments:

> "Well I got the stuff [web camera and headset] pretty late and then I got help from [person in charge of technical support] to have it installed. I don't think it was until October to be honest, mid October. Then I had a short period of problems with my [communication platform] and [text forums]. That's how it was... but then I think I got started."

Synchronization Point Three - This synchronization point was a *written instruction*. The participants were instructed to wait at a certain scene until they all have received and discussed a contract that played an important role in the Net-scenario. The activity is rising after the unlocking of synchronization point two. A few of the other participants suggest that the sixth participant should leave the Net-scenario because he is slowing the activity in the group. At this point the sixth participant logs in for the first time and he tries to catch up with the rest of the group. However, he chooses not to add to the discussions in the text forums that have been going on earlier.

The group obliges with the *written instruction* and they all wait until everyone has received and had a chance to discuss the contract. However, all participants get the contract but the level of participation in the discussions is varying.

Synchronization Point Four - This is *locked scenes* synchronization. The group is working with the planning of the project according to the contract that they were given at synchronization point three. At this point five of the participants have to wait for some days for the last one to reach the synchronization point, so most participants reached the synchronization point at almost the same time. There is discussion concerning how to vote but not as extensive as before. One of the participants says:

> "Well we all just voted at that point. There wasn't much discussion"

After this point the activity did not to rise notably again. The active participants reported in the interviews that they did not feel that it was any use logging in to the Net-scenario because at most times nothing had happened since the last time they used it and they could not continue because of the *locked scenes*.
One participant comments:

> "You logged on and looked around and, like, nothing had happened. And it isn't like I don't have anything else to do."

One important aspect is that one of the most active participants decreased her engagement and finally had to leave the Net-scenario due to personal reasons.

Analysis

In this section the use of the three different methods for synchronization is analyzed.

Locked scenes

The use of *locked scenes* worked well in the aspect that all participants are gathered at the synchronization point. However, as described in the previous section there is a problem if the group has to wait for participants for an extended time. This makes the activity decline and has a negative impact on the motivation of the group. This means that this type of synchronization point is specifically useful when a group is moving at a relatively common pace. Concerning the use of the reminders provided in the system one of the participants comment:

> "One problem is that you cannot reply to the reminder that you get by SMS, I'm not sure if that is possible to do"

Meaning that the participant cannot tell the rest of the group why they have not been able to log in and continue, as well as when they will be able to catch up with the rest of the group. This problem can be addressed by giving the participants the ability to send SMS-messages to a group of people in the next version of the net-scenario.

The reminders also created stress among the reminded users. One participant says:

> "It felt pretty awkward, really! Especially when I was reminded. I guess I had like three or four voice messages on my cell phone saying like: "Come on now!" Then you feel that you don't want that to happen again."

So if a participant is not able to work with the Net-scenario due to, for example a heavy work load, the participant is not only stressed by having much to do in his regular work. But he is also constantly reminded that the rest of the group is waiting. This created a use pattern among some of the participants, where they logged on to the activity only a few times and went through the scenes until they reached the next synchronization point. They then left the Net-scenario and did not involve themselves in any discussions. Two of the participants who adopted this use pattern comment:

> "After that [going through the Net-scenario quickly until the next synchronization point] I guess I sort of waited for someone else to take charge, like ok now its time to have a video meeting concerning this... I think... I was not too involved in the project."
>
> "You log in when you're behind in the progress of the group and work as far as you can. I think I use it for an hour at the time"

Using *locked scenes* surely brought the participants together, but it also created unwanted use patterns among the passive participants as well as frustration among the active participants. One possible way, suggested by the participants, is to give the group the possibility to exclude inactive participants.

Providing written instructions

The use of *written instructions* worked well to collect the active part of the group. If one participant did not engage in the collaborative work the group completed the task anyhow. This means that the *written instructions* worked as a synchronization of the active users but that it left out the non-active ones. This in turn left the inactive more excluded from the discussion than when using the *locked scenes* but it sustained the motivation of the active participants. One participant commented on the exclusion of inactive participants:

> "It does not feel too good that... we cannot collaborate better than that we have to wait for three weeks for one person to cast their vote.

In the *written instructions* the participants were not explicitly encouraged to remind the less active participants. The possibility for the group to decide whom to wait for and whom to leave behind empowers the active participants. The use of instructions was successful in the sense that the motivation of the active participants was kept high. However, the main idea of the synchronization points was to make the whole group proceed through the Net-scenario together and the *written instructions* failed to do this. One suggestion would be to more strongly encourage the group to keep together. One other possibility is to state more clearly when introducing the activity to the group that it is possible to be left behind if you do not participate. Making it clear to all participants that it is their responsibility to be active in the collaborative activities and that they cannot rely on the system or other participants to remind them.

Collaborative production

The *collaborative production* was effective in engaging and gathering active participants. The main difference from the *written instructions* was that the less active participants were in some cases given tasks to perform individually. The outcome was then brought into the discussions of the active participants and incorporated in their collaboratively produced result.

However, in many cases the active part of the group completed the assignments given in the Net-scenario without reminding or asking the inactive participants to take part. One of the more active says:

> "I think that [specific participant] should have done that [logged in to the Net-scenario] immediately. You have to take responsibility yourself, as a project member."

This type of synchronization also gave the group the possibility to organize their work to their own liking. The group was mainly positive to have received this power of the progress in the Net-scenario. However, during the interviews many of them showed that they expected other participants to take responsibility for the

organization. One of the participants was assigned the role of the project manager in the Net-scenario. The other participants often looked to him for organizing:

> "I expected a web meeting [this is what the group called their use of the video chat function] when we were about to finish [one of the assignments]. However, I got no indication of this"

The project manager on the other hand felt that he did not get much response on his attempts to organize the work:

> "When it comes to leading the meetings I took some responsibility, since I was the project manager... I have tried to push the group and so on, but in some cases it did not help at all"

The use of *collaborative production* managed to create collaborative activity among the active participants as well as engage the less active individually in the Net-scenario. This means that the *collaborative production* was fairly successful in comparison to the other methods for synchronization. However in the collaborative learning not all activities can result in a production of some kind.

Discussion

When evaluating the use of IT-supported collaborative learning in a professional setting it is difficult to isolate what benefits can be connected to the introduced activity and what is due to other activities that the practitioners are involved in. This is even more relevant when the learning activity is conducted parallel to daily work during a longer period, such as in this case. However, the participants were positive concerning the use of the Net-scenario and felt that they have benefited from the participation. The results indicate that the mutual engagement of the participants is a key matter. The pressure that collaborating in a group creates on each individual was not enough to motivate all participants to actively engage in the Net-scenario. Not only the engagement but also the factual possibility to put aside time to participate is important. The less active participants claim that they were committed to participating but that they just did not have the time. The stress that the reminders created can be seen as proof of this. As mentioned, deadlines were not used because this could create stress and reduce the participants' control of the progress. However, the reminders created stress among the participants who did not keep up with the groups' progress as well as made the active group halt their progress and by that controlling the progress. In further development of the Net-scenario the possibility for the majority of the active group to decide on exclusion of inactive participants should be further examined. It should also be possible for participants to more easily choose to leave the Net-scenario if they feel that they do not have the possibility to contribute.

It should be noted that the three methods for synchronization were tested in sequence with the same group of participants. This could imply that the experiences from one method would influence the participants' perception of the next. However, our data does not indicate this.

Conclusions

In this paper problems concerning participants collaborative progress in asynchronous computer supported collaborative learning is discussed. The research question in this paper is:

How can computer support for synchronization in collaborative and asynchronous learning activities be designed?

In collaborative learning parallel to work, the possibility to engage will be different depending on the daily workload of each participating individual. However, collaborative activities rely on the participants' mutual understanding of the task at hand. This means that to create collaborative activities participants need to keep a common progress through the activity. Synchronization points were developed and their use was evaluated. These are points in the collaborative activity that are intended to gather the participants in terms of progress in the online activity. Three different methods for synchronization were suggested: *locked scenes*, *written instructions* and *collaborative production*. The *locked scenes* were effective in synchronizing all participants but slowed down the groups' progress and did therefore make the most active participants lose motivation. The *written instructions* were successful in gathering the active group but failed to engage the less active participants. The *collaborative production* was successful in gathering the active group in collaborative activities and to engage the less active participants individually.

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Community Support in Universities – The Drehscheibe Project

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Abstract. Community support systems (community platforms) that are providing a rich communication medium for work or interest groups are gaining more and more attention in application areas ranging from leisure support and customer support to knowledge management. One of these application areas is the support of teaching and research activities in universities. In this article we present a community support system we have been developing and using for seven years in different university departments. In contrast to other work on community support for universities the system does not focus on lecture support or on knowledge management alone, but provides a generic communication and matchmaking medium. We will present the basic functionality of the system and elaborate into some observations we have made in the usage period.

Introduction

Several types of applications currently advertise their contribution to "community support". Using this label Web platforms and electronic commerce systems are equipped with annotation functionality (social navigation) and various communication features.

In general, community support includes all methods for supporting communication and coordination in a group of people. It includes support for direct communication, support for indirect information exchange and support for matchmaking. Community support is closely related to the application areas of knowledge management, customer relationship management and change manage-

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ment since these also deal mainly with support for communication in loosely coupled groups of people.

Using networked computers for supporting communities can be tracked back into the beginnings of the Internet. But only in the recent years integrated (Web-based) community platforms have found broad attention in research and development.

Such platforms are already in use in several different application areas. In the university domain communities like the students attending one course, the staff and the students belonging to one department or the alumni of a school can be found. The single communities can profit from the extended communication medium a community platform provides or can become a community with the help of such a platform (for example the alumni of a department that does not provide a special alumni program or alumni reunions – as it is the case for most European universities).

Most existing work on community support in the university domain focuses on supporting learning communities and on support for knowledge management in (world-wide) special interest groups. In this paper we will present a community support system that focuses on basic communication and matchmaking support in one university (or department). The system is under development and in use for seven years now and has developed significantly during this time.

After a short introduction to the topics of community and community support (Section 2) we discuss the possible usage areas of community platforms in universities (Section 3). Then we present the history and the current status of the Drehscheibe system (Section 4). In Section 5 we present some observations from the (constant) introduction and operation of the system and briefly discuss them. Finally, we will present some ongoing developments in the context of the support platform (Section 6).

Community Support

Communities

In general a community is a group of people who share some interest, identify with a common idea or more generally belong to a common context. Thus, a community can be seen as a descriptive identity for a set of people.

Early sociological work points out that communities always need a locality and interaction (Hillery 1955). While the demand for a common physical locality is no longer seen necessary, the demand for interaction is still valid. However, no active interaction among all community members is required but rather the possibility to interact with the rest of the community. In more practical terms this possibility to interact implies the existence of a common communication medium,

of common protocols and awareness of the existence and of the membership in the community.

Another characterization is that communities are based on the will to exchange knowledge. Ishida (1998) summarizes this in the following quote: "*In a community, people want to know what the others know.*" This issue can be extended to the request for collaboration in a community. A community is not just a set of people who have something in common and who have the possibility to communicate, but of people who are willing to help each other, who are collaborating to the advantage of all.

To summarize so far, a community is characterized by

- a boundary (common interest, common idea, common context),
- a sense of membership,
- ongoing interaction, and
- collaboration, mutual support.

Besides the collaboration among the members itself, the main activities in communities are communication and finding people to communicate with. Hence, community support can be seen as "*communication and matchmaking support*".

Community Support

The use of networked computers to support communities can be traced back to the beginnings of the Internet: The second service in the initial Internet, the file transfer service was soon "misused" to transfer messages from one person to another – email was invented (Hafner & Lyon 1996). Quickly mailing lists followed and Newsgroup services were available – both on the Internet (Arpanet) and on alternative networks formed of loosely connected computers (e.g. Fido-Net). The first community support services of the Internet still exist. Additionally, different (Web-based) platforms emerged, that provide virtual places for communities. Such solutions are labelled as platforms for community support (community platforms) or as community support systems.

However, community support did not start with computers. Support for the building and the maintaining of communities can be classified in classical approaches like private letters, leaflets, magazines, paper whiteboards, specialized radio and TV programs, and approaches based on networked computers (bulletin board systems, MUDs, MOOs, "community networks" (Schuler 1994)).

Both support types, the classical and the electronic ones, provide a medium that can be used for the interaction among the members. And both have their advantages and disadvantages. For classic media the advantages are availability, familiarity, and ease of use. For electronic media the advantages are dynamicity, speed, ease of replication, and distribution; disadvantages are barriers to usage, problems with access, and lack of availability.

When introducing community support systems one also should mention the terms "local community" and „virtual community". Local communities are groups of people who have their roots in the real world, meet face-to-face regularly, and use electronic information systems only as an add-on to improve their reachability. Virtual communities are groups of people who would not otherwise form a community without the assistance of electronic media. The members of a virtual community only or at least mainly communicate through electronic communication channels. Computer mediated communication is an enabler for the virtual community. In contrast to local communities, this situation offers new possibilities and dangers of anonymity. In most cases however, the virtual communication is enhanced with physical meetings. Even in communities that began as pure virtual communities the members tend to ask for and arrange physical meetings.

Generalizing the functionalities of different electronic community support tools and matching them with the basic characterization of communities presented in the previous section one can identify the following basic concepts of community support applications:

- Providing a medium for direct communication and for indirect exchange of comments on objects within the common scope of the community. The information channel can be enhanced with features that use information about the community member to do (semi-)automatic filtering and personalization (Riecken 2000, Schubert & Koch 2002).
- Providing awareness of other members and helping to discover relationships (medium for matchmaking). This can help to find possible cooperation partners for direct interaction.

Community Support at Universities

At universities different possibilities for the application of community support systems can be identified in the research, teaching and in student and alumni domains.

Community support systems for teaching

The set of all participants of a course can be seen as a community. The community is clearly defined (e.g. by explicit enrolment), the members have common interests and some kind of cooperation (learning about the topic of the course), and there is an ongoing interaction (in the course and in assignments). A community support system could support the students and the lecturer in exchanging organizational information like general announcements or announcements of date or room changes. In addition the system could provide a platform for collaboration and direct communication. Course material could be provided

on the platform and discussion forums could provide the possibility to continue exchanging about the contents of the course even away from the regular meetings.

Different work already addresses these possibilities under the labels of e-learning or computer-supported collaborative learning (CSCL). One example for a community support system that is used for this purpose is the CommSy system (Gumm et al. 2000, Bleek et al. 2000). Other systems used for supporting course communities are WebBoard (www.webboard.com) or BSCW (www.orbiteam.de). The problem with these systems often is, that they are specialized to e-learning or work group support and do not provide an open enough medium for supporting other community needs at universities.

Community support systems in departments and research groups

Community support systems could help to support the information flow in university departments. This includes the exchange of information about lectures and course programs, announcements and events, the discussion of course- and department related questions and the knowledge management in the department and in research groups.

Knowledge management is a broad application area for community support systems. The reason therefore is, that knowledge usually is hard to externalise. So finding experts and the direct interaction among people plays an important role in transferring knowledge (Borghoff & Pareschi 1998). Community platforms offer possibilities to collect information from the members and keep the link of information to its publishers. Examples for information (items) on a departmental platform would be literature references, bookmarks, and information about projects, persons or organizations. Additionally, the possibility to publish annotations and the possibility to use user-specific categorizations (personal folders) could be introduced.

In contrast to enterprises, at universities knowledge management cannot be limited to the own organization. In the scientific area it is important to exchange knowledge with researchers at other universities and research institutions and in enterprises. An example for a platform providing support for such cross-organizational communities of practice in research is the NetAcademy platform (Wittig 1999, Seufert & Gerhard 2000).

Examples for systems in the area of departmental information systems are content management applications with a portal front-end or university specific "integration solutions" like the product from Campus Pipeline (www.campuspipeline.com) or the UnivIS application (www.config.de/UnivIS/). These systems can be very useful for students and faculty, but do not exploit the full potential of community support in the university domain. There is a need to provide a more generic medium that can also be used for student and alumni communication.

Community support systems for student communication

The communication among students is an important part of academic life at universities. Since not all universities have a compact campus, regular meeting of students by chance is not always guaranteed. Community support systems could support the bridging of such spatial distances. One application would be finding partners for learning and working groups. Another example would be support of communication and matchmaking in the leisure area.

A special add-on for students would be the integration of partners from outside the university (alumni or companies) on the platform. This could motivate and support the communication between students and companies. Possible scenarios include be the installation of a market place for student jobs or a market place for ideas.

In praxis this task is currently supported by generic community support systems like UsenetNews or mailing lists. These tools offer an open medium for community interaction but they are not easy to integrate in emerging portals or other platforms.

Community support systems for alumni

Several European universities started to integrate their alumni in the university network recently. Central institutions are founded that maintain alumni databases and that organize common events to foster the communication among alumni and of alumni with the university members (faculty and students).

Community support systems could help to create a common identity of all alumni of a university and thereby create an alumni community. A communication platform for alumni could support both the information flow among university and alumni and among the alumni. The set of alumni of a university thereby gets a more graspable form and is more easily addressable for university members and for students.

Existing platforms for supporting alumni interaction mainly provide address lists and bulletin boards for the alumni. However, there is no integration with the systems for active students or for the department.

The Drehscheibe Project

Most of the existing community support platforms in universities address the areas of supporting learning communities or of supporting research groups in information or knowledge exchange. In contrast to this our project focussed on providing a generic medium for supporting communication and matchmaking in universities, in particular for students and alumni. The resulting system was labelled *"(Informations)Drehscheibe"* (German for *"(information) turntable"*).

In this section we will present the history, current status and technological solution of the Drehscheibe platform.

History

In the year 1995 some people in the Department of Informatics (Computer and Information Science) of our university decided that it is time to replace the (always late and never up-to-date) printed version of the course catalogue by an online version. So we started to implement a Web-based course catalogue with functionalities for planning and coordinating future courses (for the faculty) and for maintaining online-timetables (for students and faculty).

The service grew and we soon extended the focus to building a "platform for information exchange and matchmaking" in the department – a community support platform. We identified different target groups. These were students, alumni, faculty and external (future students, external researchers, companies). Regarding the target groups we decided to focus on supporting information exchange, communication and awareness (matchmaking) for students and alumni while providing a very flexible medium that might also support other fields. This task was accomplished in several steps. The system was restructured, was re-implemented and was linked to several other systems and resources. During the development the solution was adapted by other departments and universities and in this turn extended with various possibilities for configuration. In the following subsection we will briefly describe the core functionality of the system as it is in operation today.

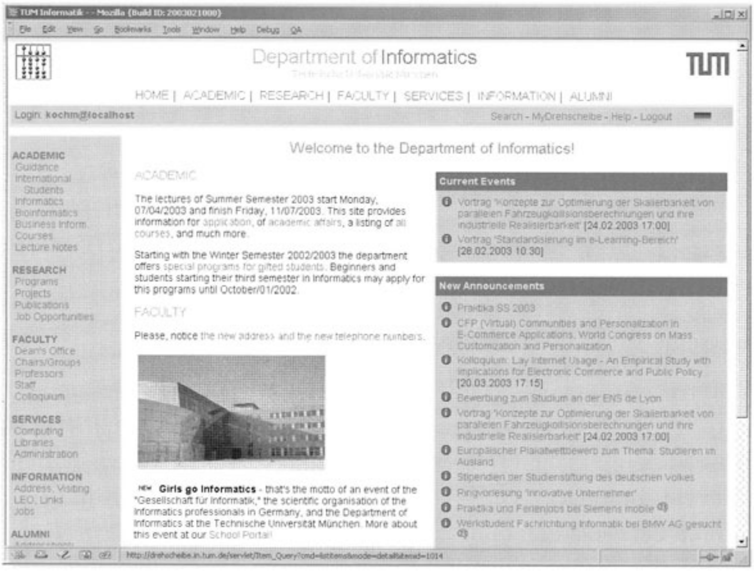

Figure 1: Homepage of the Department of Informatics of TUM with Drehscheibe functionality

Functionality

Focussing on communication and awareness (matchmaking) support we began to develop a generic community platform that provides the possibility to easily support different (overlapping) sub-communities in one installation. The members should mainly be supported in exchanging information and comments. To exploit the community and to provide awareness all information should be linked to the publishing user and it should be possible to easily get information about community members.

The platform currently offers the following functionality: 1) Publishing (semi-) structured information, 2) Community spaces, 3) User representation and match-making, 4) Communication and awareness, and 5) Web-content management.

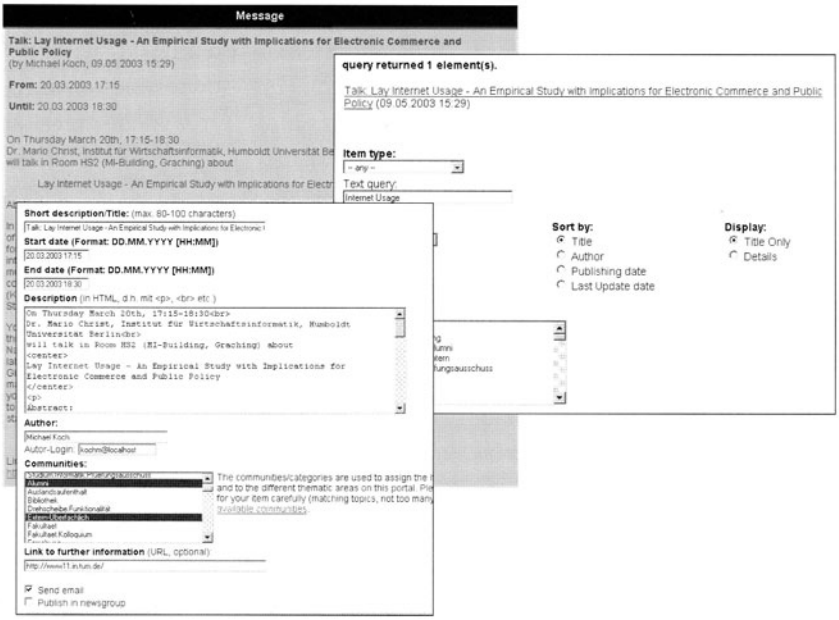

Figure 2: Item functionality in Drehscheibe (Publish, Search, Display)

Publishing (semi-)structured information

The central part of the system is a simple but very flexible and extensible functionality for publishing and receiving information and comments. The information that can be published ranges from simple free text announcements, semi-structured event announcements (with attributes for timeframe and location) to fully structured data sets like bibliographic references.

To provide this functionality in a very generic way, different information object classes can be defined in a data model. The model is based on a frame

based approach and defines attributes (slots) with types and default values. Object classes can be related to each other in a class hierarchy (is-a-relationship), and attributes can define a instance level relationship to user or course objects. Defining the model can be done using ontology editors (e.g. the Protégé editor), which keeps room open for future extensions of the model. On the departmental platforms we currently provide object classes (and appropriate user interface templates) for announcements, events, bookmarks, project descriptions, research topic descriptions, publications, job offers, and special classes for announcements in the academic programs. Instantiations of these information object classes are called (information) items. Such information items can be created by any registered user of the platform. Items can be rated and it is possible to publish annotations and comments to items.

Selections of the items can be displayed on Web pages of the community information space (see Fig. 1), can be searched by the user or can be sent pro-actively per email according to a user's subscriptions. Such subscriptions can ask for sending new and changed items immediately, once a day, once a week or monthly. A special way to present items that have a duration attached to them (starttime, endtime) is implemented in the calendar component. With this component the items can be displayed in a day, week or month view.

Regular lectures are currently modelled as a special item types. It is possible to publish comments to lectures and to define subscriptions (e.g. for new lectures, changes in time or room). Lecture items can be organized in a timetable. This information about lectures a student is visiting or has visited (timetables are stored for previous terms too) is used for providing recommendations for lectures to visit using collaborative filtering techniques (e.g. like "student who has visited this lecture has also visited that lecture").

Community spaces

To structure the item sets (and the user sets) we have adapted a very flexible community (or category) concept. Every registered user can create a new community space and place it in a hierarchy of already defined community spaces. Such a community space has a name and can have members (association of platform members with the space). If the space is declared "open" every user can decide herself if she wants to become member of the community (space). In closed spaces the administrators of the space have to decide about membership applications or have to invite members explicitly. Items published to the platform can be associated with one or more of the community spaces. Attributes of a community space determine if you have to be a member of the space to associate information items with the space or to read items associated with the space. Additionally, community spaces have a freely editable homepage and any number of static web pages that can be edited by the members of the space.

The community spaces serve several purposes: First they are offering a possibility to flexibly structure the members of the departmental community into several smaller sub-communities. These sub-communities can be used to define access rights to items and thereby to determine who will receive published information. But the sub-communities also carry some information in themselves. The association of users to sub-communities tells something about interests and relationships between users. The interest and membership information is used to define subscriptions for new and changed items. Therefore, the interest relationship is enhanced with a notification rule (immediate, daily, weekly, monthly). The membership relationship aspect can be compared to the well known buddy lists defined on a per-user basis. Since the different members of a sub-community can collaboratively edit this list of members we also refer to the concept as "SharedBuddyLists".

So, the concept of community spaces is much more than simple categorization of items and users (by their interests). Even if only used this way, the implementation provides one very important add-on to existing systems that provide sub-communities like Yahoo! Groups: Since items can be easily associated to more than one community, it is easy to publish information to different communities. In the same way it is easy to collect information from different communities. This aspect is of major importance for the usability of community support systems since people usually interact in more than one community. Existing systems do not support this fact but usually make it hard to deal with different communities at once. Providing the possibility to easily interact in different communities at once makes the support more intuitive to users and thereby serves making the support platform a medium instead of a tool.

User representation and matchmaking

In community support systems the representation of users is even more important than information exchange. Reference to the community members is needed to put an information item into context and to provide possibilities for finding other community members for direct interaction.

We provide a possibility to store different information about a user (static attributes, interest attributes like the relation to community spaces, relationship attributes like buddy lists). Since the information is not only used in the system, the user can specify how this information can be presented to other users (not, everybody, buddy list only). Information about users is presented on user information pages that are linked to all information the user has published. These user information pages also allow to search for all items a user has published.

In addition to finding users from information they published on the platform, it is also possible to search users by their attributes. One case where this functionality is used a lot is the alumni class lists. Especially for alumni we also

provide a notification service for changes in the user data (e.g. address information).

Finally, one important feature that was requested by the users was to add a photograph to the user information and to allow a “search by pictures”. Therefore, we provide pages that show all pictures of students from one semester / class.

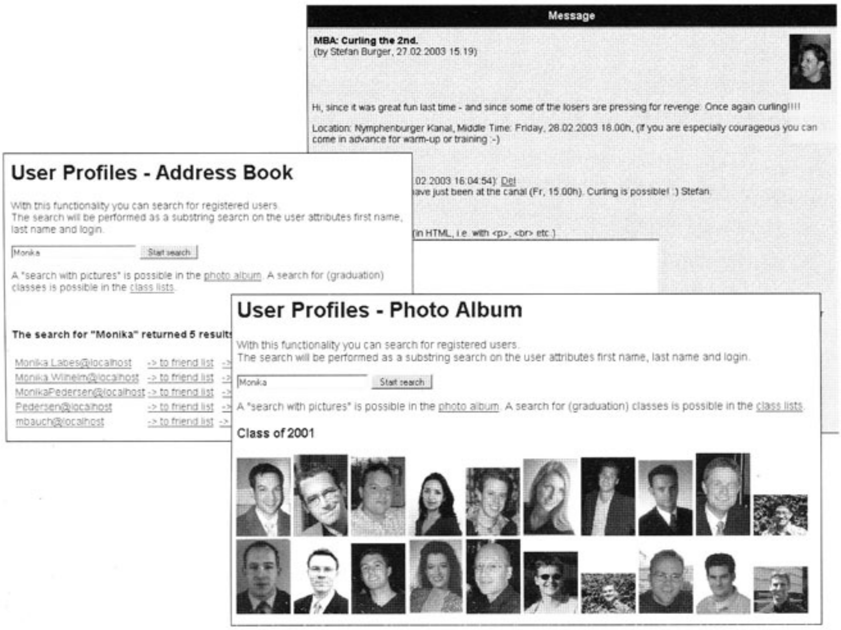

Figure 3: User lists and User representation with items

Communication and awareness

By adding comments to the semi-structured information items asynchronous communication among the members is possible. The Drehscheibe platform does not provide any further support for direct communication. We assume that the users already use other communication channels (like email or telephone). So, it is enough to provide contact information and awareness of other users. The awareness is provided by displaying lists of (currently active) community members, by prominently showing the author information when displaying information items, and by offering services to search the user database.

User interface, Web-content management

While first the functionality presented in the previous paragraphs was separated from the static information on the departmental Web site, soon the demand raised to combine the static information with the communication and matchmaking functionality (for registered users). Hence, we implemented a small web content

management functionality that provides functionality for defining page templates and for editing Web pages via the browser or for uploading them via FTP or WebDAV. In these Web pages placeholders can be defined that are filled with information from the item, user or community databases. Using this template mechanism it is also possible to provide personalized pages for authenticated users.

Implementation

During the development we have been experimenting with several technologies and architectures for the implementation of the Drehscheibe service. Before going into more details here we briefly have to sketch the general conditions of the development. Since the project never has been a funded research project, but "just" a good-will infrastructure project, there were no employees assigned to the project. There where just one or two employees from the Informatics department who took managing and implementing the platform as an additional assignment and worked with changing teams of students who did their programming projects on components of the platform.

We have started the project as a PHP application in an Apache Web server with a MySQL backend database. However, this implementation basis was dropped after one and a half years because PHP did not provide enough support for modular development. It became very hard for new students to understand existing code and to extend it. PHP proved to be a good basis for a small, coherent set of developers, but did not match the project conditions we were facing. So, we switched to Java (Servlets, Java Server Pages) as an implementation basis. We are now using Tomcat as an application server and are still relying on a relational database for the backend storage (currently MySQL, Postgres and Oracle are supported). For making it easy for developers to install their own development environment we are using CVS for version control and are providing a Java-ANT-based build script for setting up the system and for starting the application server.

To provide flexibility for adaptation and for interoperability (also see Section 6), we have designed a highly modular set of components for the system. This development was generalized in the project Cobricks (Koch 2000, Koch 2002a, Koch 2002b) and currently serves as implementation basis for several community support platforms in our group (Koch et al. 2001, Koch et al. 2002, Reichwald et al. 2002). Basis of the system design for Cobricks platforms is a classical separation of user interface, backend services and database access.

Backend Services

For the backend services we have identified different components and have implemented them separately. The separation of the components is mainly guided by the different data concepts available in the platform:

- Content and feedback management
- User (profile) management
- Message management (including newsletters)
- Community management
- (Web-)Page management
- Course management
- Timetable management

The backend services provide their functionality via (remote) procedure call to the user interface layer.

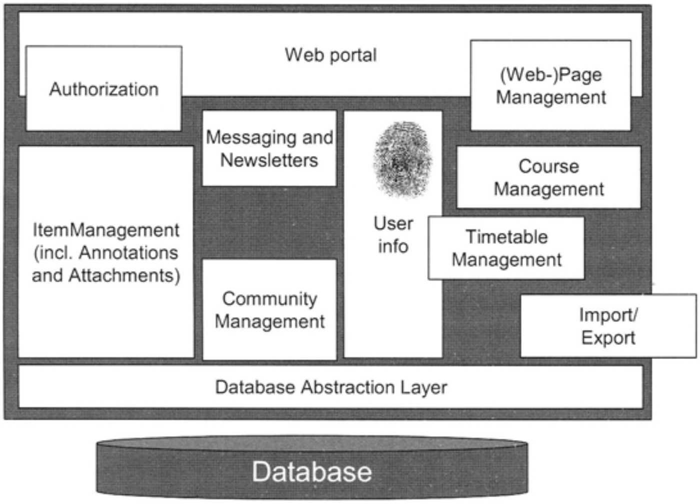

Figure 4: Cobricks system architecture

(Web-)User Interface

The user interface provide access to the backend services and implement the "real" community services. For the Web-based user interface we are using a template based Java Servlet solution which is quite similar to Java Server Pages – i.e. the functionalities are implemented in servlets but rely on template files that consist of HTML text with placeholders for data. Those placeholders can refer to attributes of specific data sets or to functions that return some content. Content returned by functions usually is XML and is transformed to HTML using XSLT stylesheets. With this solution it is very easy to customize the user interface.

In addition to the Web-based user interface we also provide a Web-Services interface to the backend services that can be used by user agents or by external tools.

Drehscheibe – Usage Experiences

Because of the possibility to flexibly support sub-communities at the grassroots level and the flexibility in design and organization of the information space, a single installation of the platform could theoretically cover all applications in the whole university. However, this approach (one central platform for all) according to the experiences of the author leads to resistance from the responsible persons in the different departments. It is seen as restriction of their own individuality and freedom – especially in German universities.

So in the moment we already have two instances of Drehscheibe operating at our university – one for the Department of Informatics where the system was designed and developed, and one for the Business School (Department of Economics). More installations are already planned in other departments and research groups. A third installation is currently in use in the Department of Informatics of a neighbour university.

In the remainder of this section we will present some observations from the actual usage of the system. Since we have never done a real usage study, but just peripheral observation, we mainly present some distillations from these observations and some lessons we have learnt, but do not support them with numbers. A full study of the user activity in the different instances of the system will follow in the future.

Active students - passive students

The usage of the two Drehscheibe instances in our university is quite different. While in the Informatics Department the platform is mainly used to distribute announcements from the department, some external sources, and from the faculty to the students, in the Economics Department the platform is mainly used for communication among students. So, with the same set of functionalities different usage patterns have developed.

One reason for the different developments could be the different composition of the students and the spatial distribution of the students. While in the Informatics Department there are mainly students in their first course of study, in the Economics Department there have been older students that already have finished a full course of study and are now doing a MBA. In addition to the difference in age and experience the two groups differ by the spatial distribution. While most lectures for Informatics students are in one area of the campus, the MBA lectures (and therefore the students) are distributed over large areas of Munich.

Another reason for the different development could be the different technology already in use by the students of the different departments. The Informatics students already have some established community platforms in place: UsenetNews and IRC. A qualitative survey showed that these media are much

more actively used by students than the departmental communication platform. Additionally, the student groups in the Informatics department share the "engineering position" that only a system developed by oneself is a good system, and therefore still develop and use their own mailing list and portal based platforms for distributing information. The Economics students did not have communication channels in place and are less driven to implementing own systems. The only tool that is in use by a high percentage of Economist students is Instant Messaging. Examining the influence of this to the usage of the departmental platform will be one of the goals of a future study of the system. We are also starting to implement bridges from and into different media (particularly UsenetNews).

Finally, we consider the "ownership" of the platform as one possible reason for different or low student activity. In the Informatics Department the platform was always maintained by staff from the department. In the Economics Department the platform was set up as a result of a student project and was maintained by students for a long time.

Usage of existing features

Another result we can present from the operation of the platforms over several years are patterns in the usage of the provided features and requests for new features. For making the platform an integrated support medium instead of an isolated support tool we introduced different functionalities. The core functionalities were the flexible usage of sub-communities at grassroots level and the awareness features.

When enabling the sub-community functionality we provided the platform with an initial set of thirty communities covering topics from academic programs, exams to leisure activities. While we imagined that users will make intensive use of creating additional sub-communities, we observed, that there were only few new communities created during the last years. Examples for new communities were communities dedicated to the exchange around particular lectures or new academic programs. Users did not create other general-purpose communities – but there was feedback to the administrators of the platform about the usefulness of existing communities and some changes were made according to this feedback. Asked about why they did not create communities themselves, users mainly responded that they did not know/feel that they were supposed to "change the structure of the system". Because of these results we improved documentation of the functionalities and started a small campaign to convince users that they are allowed and even supposed to help structuring the departmental community support system to their needs. This campaign is still in progress, but already shows some positive results – however very slowly.

While the feature of creating new communities did not attract the expected attention, the users very much appreciated the easiness of interacting in different

communities. The importance of interoperability among communities and tools was also highlighted by the users indicating the email notification and newsletter service as a key feature of the platform. But there were also some problems with this. We had to fight two developments: 1) Some users felt, that their information has to reach all other users and published it in all available public communities (because it was so easy); 2) Other users thought that they just have to publish information on the platform, without having to specify any communities. These developments of neglecting categorization schemes can also be found in the application of knowledge management tools.

The awareness functionality was quickly accepted by the users as a possibility to identify other users and to get in touch with them. They even proposed additional functionality to support searching in the user database (see next subsection).

Around user lists we also discovered an "abuse" of a functionality implemented for alumni. So we provide an attribute in the user profiles that is labelled "year of graduation" and have built some features for displaying class lists and for subscribing to notifications about address changes of members of the same class. While meant for alumni only, we soon found entries of future years in this attribute. Active students have started to use this field to register their predicted year of graduation to provide information about their current status. This is especially interesting since the students in the department do not form a real class (there are 500 to 1000 students beginning in the same year) and usually are not finishing after the same time.

Requested features

Features requested by the students first where the possibility to add file attachments to items. The students wanted to share lecture notes and other larger documents this way. Another feature related to the attachment feature was the possibility to have virtual team rooms for document exchange. We experimentally installed a BSCW server in addition to the Drehscheibe service to provide this functionality in the Economics department and found that the students made extensive usage of it.

From the departmental staff the major feature requests were additions to the (Web-)page management and to the content management functionality needed for efficiently managing a multi-language Web-site administrated by different people from different groups.

Finally, there were several requests for providing interoperability with other platforms. Examples are providing a single-sign-on solution with other platforms from the department or from research groups, or exchanging data with UsenetNews.

Expansion

In addition to experiences in the usage of the platform it might be interesting to report some experiences from setting up the platforms and from handling operation and integration.

After some good experiences with the first two platforms we soon extended our plans to include more services from our department and to extend the scope to the whole university. For the latter we planned to set up a new platform called "TUMmelplatz" (German for "romping place") to support communication on a university level. This platform should integrate departmental platforms and act as a forum for all alumni and people interested in the possibilities the university provides. Additionally, we wanted to equip the platform for supporting cross-departmental cooperation.

Both in actively getting more actors from the department into the project, and in setting up a platform on the university level we deeply stumbled into responsibility problems. When different actors where involved that all had their own ideas of what a support platform should be and what not, getting commitment got more and more difficult. And since we were missing explicit support from management most of the efforts failed.

So finally, we stopped trying to expand. We are now focussing on developing interoperability functionality to finally integrate all the different emerging platforms again in one or another way.

Summary and Future

In this paper we have presented the Drehscheibe system for supporting communication of students and alumni (with faculty) at universities. In contrast to the (isolated) tool character of some other community support systems at universities we concentrated on providing a communication and matchmaking "medium". The medium aspect mainly shows in the provision of simple but generic features that can be used to support different activities, and in the integration of different communities and with different other media (like email). So, it is not even necessary to directly interact with the platform to make use of it – information can be published and received via email. One of our future tasks will be to further shape the basic building blocks and interfaces for such "ubiquitous" community support platforms (also see Koch (2002c)).

On the feature side we have highlighted the communication and awareness features of our platform. While some of the features developed towards content management functionality we still focus on community aspects of these functions: linking users to content and making publishing possible for all.

We have mentioned, that the natural development is towards different community or service platforms even in one organization. This development leads to some problems:

1) Users have to register explicitly at the different platforms and have to enter their profile information (e.g. the demographic information and interests) again and again.;
2) There is no possibility to automatically publish information on different platforms or to ask for information or news from different platforms.

We are currently addressing these interoperability issues in different projects including work in global identity management (Koch & Wörndl 2001, Koch 2002a, Koch 2002b, Koch 2002c, Koch 2002d, Koch & Möslein 2003).

Finally, we are currently working on extending the Web-user interface to other user interfaces, that can be embedded into non-virtual place. In this context we are experimenting with large screen devices and with mobile devices that provide access to different parts of the Drehscheibe.

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Adding connectivity and losing context with ICT: Contrasting learning situations from a community of practice perspective

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Abstract. The promise of information and communication technologies is that it increases connectivity. By providing a spectrum of technologies such as email, web conferencing, telephones, and chat, ICTs bring people who are geographically dispersed together in community. Such communities can provide a new context for learning; at the same time, the social, physical, and technical context of the community's members risks getting lost through computer-mediated communication. Design for online communities, especially design for learning in online environments, tries to find ways of re-inviting participants' contexts, as context has a great bearing on learning, in fact is inextricably linked to learning. In this paper we investigate the complex relationship of context, technologies and community design issues. We present three case studies of online learning communities and analyze the interplay of context and technology for each situation, using a community of practice perspective. Each case balances the demands of time, the need for context, and the demands of practice in a unique way. The insights gained can inform both educational design and design of community technologies.

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Introduction

Information and communication technologies (ICT) are thought to promise great change in social practices and the learning that occurs through them – both inside and outside of organizational contexts. ICTs add connectivity: geographically dispersed people can form online communities within an organization, cutting across organizational boundaries or completely independent of organizational affiliation. Using the added connectivity to support communities indeed becomes an indicator in many fields as to how fully ICTs' potential is harnessed (cf. Brown and Duguid 1996 for the digital university). In many fields research projects investigate what sorts of designs are most conducive to producing and nurturing online communities (e.g., Paloff and Pratt 1999, Bielaczy and Collins 1999, Preece 2000). Other research focuses on what happens when a community's communication is transferred into the online space due to changing organizational structures (e.g., Kimble, Hildreth and Wright 2001). Research-practitioners such as Salmon (2000) show how new skills enable new social spaces for learning.

At the same time computer-mediated communication and communities that rely heavily on these new media are confronted with significant limitations: lacking social cues, making do with gaps or lags in feedback, and dealing with "noise," for example. Communication becomes relatively "thin," reducing the context that communication partners effortlessly share in face-to-face situations (Hesse, Garsoffky, Hron 2002). This loss of context and how it masks situations and identity so that one person can pass for another is pointedly encapsulated in the famous cartoon from The New Yorker magazine where one dog says to another, "On the Internet nobody knows you're a dog." Similarly, we normally don't know the context at the other end of the messages we send (cf. Figure 1).

How does this possible loss or distortion of context impact communities and their learning? We understand learning to be a situated social practice that is inextricably linked with its context. But the context of social interaction through ICT is inherently difficult to see. The new possibilities and corresponding restrictions introduced by technologies for negotiating meaning or understanding others' context become crucial issues when we design for online communities and facilitate learning within them. Up to now little consideration has been given to the intricate relationship between *participants' contexts*, *design for communities* and *technologies* for communities and learning.

Figure 1: Email in context

In this paper we explore this relationship in more depth. We examine three cases in which technologies enable learning situations. In each case the use of technologies is deeply intermingled

with issues of losing context and re-constructing it through the design for learning and the community's actual practice.

We derive our theoretical framework for this analysis from a communities of practice (CoP) perspective (Lave and Wenger 1991, Wenger 1998). All three cases are examples of online communities that in one way or another focus on learning. Each case uses a different mix of technologies and each occurs in a different social context. In each case different ways have been found to deal with the fact that only a part of a participant's individual context is transmitted by ICT. In each case a new, emergent collective context is created through the technologies. The cases cover a broad spectrum of learning situations: a higher education *online class* designed according to CoP learning principles, a *workshop* offered for professional development that simulates a CoP online, and a students' *self-organized network* that relies heavily on internet technologies as students are dispersed distance learners.

As regards methodology, the case studies as such use an action-research approach and grounded theory methodology. We apply a CoP perspective for a comparative meta-analysis of the cases.

The purpose of this investigation is to unpack some of the inherent complexity of the interconnectedness of community design, technologies and context. Our results will inform educational design as well as the design of technologies that are developed to support learning, thus feeding back into our own contexts as researchers and designers who focus on community support and development.

The structure of the paper is as follows. In Section Two we elaborate on context, connectivity and learning and thus develop our CoP perspective for the analysis. In Section Three we present briefly three case studies, focusing on contexts, design and technologies involved. Section Four analyzes learning situations in the three cases and investigates the particular ways that technologies, design and context interact and shape the learning in each case. We conclude in Section Five by reflecting on the results of the analysis and their implications both for design issues and for further research.

2 Context, connectivity and learning - a CoP perspective

The promise of connectivity seems to be neatly defined: ICTs enable us to communicate and cooperate with people living thousands of miles apart and to connect across different time zones, choosing between asynchronous media (such as e-mail, file-repositories, news-groups, web conferencing, or blogging) on the one hand and synchronous technologies (such as chat, telephone conferencing or application sharing) on the other. Having these different technologies available gives us the opportunity to choose individually and to collectively negotiate gradients of synchronization, "freeing us" from time and space to a certain degree. Online communities of various kinds come into existence, some deliberately designed for learning, others as networks around a topic that may develop a shared practice. In cases such as ParentSoup or PerlMonks, communities provide

a context for learning in the broad sense that learning is used in this paper (and on which we elaborate later).

Given growing connectivity (at least in western industrialized societies), information resources are available worldwide. With the proliferation of new technologies, choosing and combining resources and technologies becomes an increasingly complex task for the designer of learning situations. Similarly, choices between all the available media, resources and technologies that are available require and enable learners to act more like *designers* in the sense explored by Fischer (2002) rather than just being passive *consumers* (cf. as well Wiley and Edwards 2002).

However, there are caveats as well: Research on computer-mediated communication (CMC), on computer supported cooperative work (CSCW) and on computer supported cooperative learning (CSCL) reveals a far more complex picture. According to many studies in these fields, the "death of distance" or the "the end of geography" is a myth not a reality: communication and cooperation that are mediated by technologies are often still restricted in many ways. Some studies indicate that reduced information about personal context, the lack of social cues, cognitive overload and a lack of coherence in the exchange of messages can impair communication and cooperation. Trust building and social bonding in virtual communities seem to be more difficult than in face-to-face situations (Hesse, Garsoffky and Hron 2002, Kimble, Li and Barlow 2000). Presently there is no clearly established consensus of research findings. Contrasting results prevail, pointing to a large number of complex factors to take into account. The time dimension, for example, is problematic in this way: when minimal time is available, computer mediated communication tends to restrict the development of intensive interpersonal relationships, to dissolve social hierarchies and thus foster more egalitarian dialogue. In contrast, in online communities that exist over a longer period of time, the converse seems to be true in the sense that intensive interpersonal relationships can and do evolve online (Walther 1992; 1996)

Furthermore where technologies from a usability perspective should be transparent ("the invisible computer", Norman 1998), allowing the user to focus on the task at hand rather than on the technology itself, in fact they rarely are so. CSCL research points to many examples where attention is shifted from the cooperation or learning task towards the handling of technologies themselves (Reinmann-Rothmeier and Mandl 1998, Hara and Kling 2000). Technical flexibility is a key factor when introducing groupware into organizations (cf. Wolf 1999). In most cases many workarounds and improvisations are needed to make up for the various constraints and limitations of any given technology or mix of technologies. Specific, creative and complex ways of coping that are at work in the cases under investigation will form the empirical basis for our inquiry.

Connectivity thus leads directly to the importance of context for any given social practice. What exactly do we mean by context? There is a prevailing misconception of social context as a *container* - "a static, residual, surrounding 'container' for social interaction" (Lave 1993, 22). This misconception leads in turn to the widespread belief in the existence of decontextualized activity. If the concept of context is that of a separate entity that can be disconnected from social

practice itself, the notion that educational institutions like schools are a "privileged noncontext" (Lave 1997, 126) only seems logical. McDermott (1993, 282) describes this connection precisely:

> "In all commonsense uses of the term, context refers to an empty slot, a container, into which other things are placed. It is the "con" that contains the "text", the bowl that contains the soup. As such, it shapes the contours of its contents; it has its effects only at the borders of the phenomenon under analysis [...] the soup does not shape the bowl, and the bowl most certainly does not alter the substance of the soup. Text and context, soup and bowl [...] can be analytically separated and studied on their own without doing violence to the complexity of the situation. A static sense of context delivers a stable world."

In contrast to this restricted and misleading concept of context we argue with Chaiklin and Lave (1993) that context must be conceptualized as a social world in relation with persons acting, as practice itself, inextricably linked to human activity. Context is the social world of a person:

> "A more promising alternative [to deal with context] lies in treating relations among person, activity, and situation, as they are given in social practice, itself viewed as a single encompassing theoretical entity." (Lave 1993, 7)

Learning then is contextual. It happens in space and time, is informed by the context of the past, is validated with one's current context, and context shapes the future (through "the living present", Shaw 2002). Context in this understanding – like a window into a learner's social practice – bears on a learner's intentions, assumptions, interpretation of terms, and style of participation. Although context has such a huge impact, normally it is invisible to us until we engage in processes of interaction or of reflection (Maturana and Varela, 1992, 210) where we can look at "where we stand" – on an issue or in a social space.

From what has been said so far it is obvious that we don't support the common and very narrow concept of learning as merely a cognitive process. In contrast to cognitive learning theories we look at learning as a situated social practice. To take a communities of practice perspective on learning in detail means to conceptualize learning as participation in ongoing social practice, moving from legitimate peripheral participation to full participation in a given community of practice. Learning in this broad sense can be understood as "part of the subject's moving, changing participation across multiple contexts of their daily lives" (Lave 1997, 123). Serendipity and improvisation play a much larger role in this movement when "learning" is seen as more than a cognitive process, always being inextricably linked to identity building.

What role does instruction play in a CoP perspective on learning and what does a teacher look like? Instruction in this view becomes one of many learning resources. As Wenger (1998, 266) points out: "Instruction does not cause learning; it creates a context in which learning takes place, as do other contexts." Hence the teacher or instructor constitutes one of many learning resources. The intricate structuring of a community's learning resources comprises the actual practice, shared between the instructor and other learners, involving the entire social network of the community. As the technologies and processes for coordinating their use become more complex, we argue that learners and teachers collectively engage in a design process that goes far beyond the social interactions in a traditional classroom.

An important point distinguishing this approach to learning (and the resulting approaches to the design for learning) is that learning environments cannot and should not be sequestered from practice environments – somehow the different contexts of different members of a community of practice must be visible as members interact with each other and with the community's practice. We see the setting for learning, whether consciously designed or inherited from forebears, becoming a shared context with its own meaning and potency. Learning then occurs within an improvisational process of engagement in collaborative problem solving in that shared context.

In our comparison of the three online learning cases we use the scheme described by Wenger (1998) of the constitutive elements of a community of practice. Domain is the subject of a community, the knowledge area around which the community gathers and which the community's practice exercises. In the concept of community we include the people, their relationships and their trajectories toward the development of knowledge and competence at an individual and collective level. By practice we refer to the habits and activities that the community uses to apply its knowledge domain or which are involved in being together as a community. Practice entails the learning that happens in a community, changing and transforming member's identity and at the same time being transformed and changed as members manifest their identity within the community. Practice and identity are used here as two complementing analytical perspectives to assess the learning in the three cases (for the complementary nature of identity as a dimension to analyze learning cf. Wenger 1998, 45). These dimensions together provide a helpful lens to examine the issues of technology, connectivity and context.

In summary, connectivity, context and learning seem deeply tied to each other. In the following sections we examine in which ways design for communities can mitigate the potential loss of context and can foster learning by allowing members to develop a community's practice as well as their individual identity.

3 Increased connectivity: three case studies of online communities

Although we emphasize the problematic nature of ICTs, it must be clear that none of the cases we examine here could have been possible without the increased connectivity afforded by new technologies. Each of these cases have been treated in more depth elsewhere (for the *online class* cf. Putz & Arnold 2001, for the *workshop* cf. Smith & Coenders 2002, for the *self-organized network* cf. Arnold 2003). Neither the many rich contrasts between them nor the methodological details of the case studies can be exhausted in this paper. Our interest here is focused on the theme of context and technology: how the individual learner's context is included in the online learning environment and how the collective context of the learning community is made explicit, becoming a resource for the community. In this section we introduce each case by providing basic descriptive information. We then use the Wenger (1998) framework to briefly describe

domain, practice and community elements for each case. Finally, we characterize the design for learning and summarise available data sources and our connection or involvement in each community. To make the discussion of context easier to follow, we provide an overview in Table 1.

Table 1: Synopsis of case characteristics

Feature/Case:	**A Online Class**	**B Online Workshop**	**C Students' Network**
Participants	Full time student	Working professional	Part-time student
Institutional framework	University class offered for credit toward a degree	Training offer from CPsquare with no official "credit"	Self-organized community within a special distance education degree program
Technologies used	BSCW for asynchronous, web-based discussion groups and file sharing	Web Crossing for web conferencing, file sharing, chat, and instant messages; also phone conferencing, email, Groove, etc.	Listserv, newsgroups, websites, and web-based discussion forum
Authors' roles	Guest experts, researcher	Designer, producer, facilitator, participants, researcher	Researcher

An Invited-Aligning Community: An Online Class in Higher Education

This online class on knowledge management in an Austrian brick and mortar university has lasted 10-15 weeks, has involved 12-15 students each time (it's been offered twice). The design includes no face-to-face elements. All of the learners in this case are within one time zone, selecting the class to enjoy the greater flexibility of an online seminar and to acquire competencies and experience with new media. The community's domain is knowledge management from a scientific or scholarly (rather than applied) perspective. The practice is scientific investigation of various aspects of knowledge management, applying academic procedures such as analyzing texts, engaging in written debate, and producing individual summaries and contributions. Compared to the other cases, the domain aspect receives much greater emphasis and the community element receives somewhat less. Our analysis of this case is based on participating as guest experts, re-reading the logged communication and analyzing evaluation data (the reflection circle and a questionnaire; cf. Putz and Arnold 2001). The technologies involved in this class include an object-oriented groupware platform (BSCW) with asynchronous communication tools such as newsgroups, data repositories, and e-mail. No synchronous technologies are used, although work is scheduled in important respects by the assignment of discussion topics and individual tasks, which are due by specific dates.

The design of the class aims at enabling the legitimate peripheral participation of students in a larger scientific community (which is present through its

publications, the field's canonical stories, the instructor, and the guests) and provides trajectories to fuller participation. The design tries to integrate a community of practice perspective into the existing organizational culture and value system of higher education. Initially, students begin by reading finished products (the class readings), and gradually take more responsibility for producing their own comments and expressing their own understanding of the material. The schedule provides time for the discussion of emergent themes. There are several explicit social roles in the community that are identified at the beginning and are enacted during the course of the class. These include: the instructor, guest experts, student-leader (specific tasks for which students volunteer), and student participants. The proximity of this class to a traditional classroom context is palpable in many ways: students are of similar age and they are receiving credit toward a degree. They are invited to reflect on scientific procedures (both those they are carrying out and the procedures that are established in the field), comparing the way these procedures connect and shape each other mutually.

An Encouraged – Negotiating Community: an Online Workshop for Professional Development

The second case is an online workshop on communities of practice that currently lasts seven weeks, has between 20 and 40 participants, and has been offered about 10 times in the last 5 years. It draws a wide variety of people from many economic and social sectors (and many time zones) for professional development and has no face-to-face components. Originally developed in an entrepreneurial mode by its organizers, it is now part of CPsquare, a non-profit organization focused on communities of practice. The domain of this community is communities of practice. The practice is a collective, practice-oriented inquiry about communities of practice in an online environment. The community aspect receives a great deal of emphasis in this case, through planned activities (i.e., an opening and closing circle, community meetings on a telephone bridge, and student-hosted guest visits), spontaneous activities (i.e., games, weddings or holiday observances or chat parties), nominal groupings (i.e., groups of four people who form into "households" and sign up for leadership tasks, discussion tables composed of people from different households, and project teams self-organized around a topic), and the differentiation of "teaching" roles (that include a domain expert, a community organizer, a practice coordinator, guest speakers and mentors). The authors have had ongoing participation in this workshop (Smith as a participant, designer/technologist, and community organizer; Arnold as a participant and researcher). Archives of web conferences, surveys, meeting transcripts, and interviews form the basis of our analysis in this case.

The technologies involved in this workshop are built around Web Crossing (which provides web-conferencing, instant messaging, email notification, shared files, and chat). Audio conferencing via a telephone bridge provides another mode of conversation and email is used for announcements and back-channel exchanges. Small project groups can use other technologies for collaboration.

Although in several regards the workshop is very carefully designed, in many ways it is *under-designed* (in the sense developed by Fischer 2002). That is, although some elements such as telephone meeting times are set in advance, much design occurs spontaneously, during the workshop. For example, many of the topics of conversation are drawn from individual interests of participants, from cases they bring for discussion, or from events in the workshop itself. This evident under-design is used to encourage participants to bring their individual context, experience and perspective into the workshop. A barometer (Smith & Coenders 2002) and an ongoing discussion about "reflecting on our experience" (which is facilitated by a group of participants who volunteer for the task) are important ways of pointing to the collective context that evolves in the workshop. The availability of project reports produced by workshop participants in subsequent workshops is another way in which the emergent community context becomes visible and available as a community resource.

An Enacted-Developing Community: Grassroots Student Network in Distance Education

The third case is a grassroots students' network of between 500 and 800 students. Distance learning students who are enrolled in a specific distance education degree program set up an online community structure beginning in 1995, using basic Internet tools. It is set up, run and administered technically by the students themselves, independent of the distance education provider. It is an ongoing community that also organizes regional, informal face-to-face-meetings. Additionally, students meet face-to-face in small subgroups in daylong residential seminars as part of their degree program and when taking exams.

The domain in this community is primarily expertise and "survival" as a distance learner, obtaining a degree over 3 to 5 years, while holding full-time jobs. Business informatics and business administration, the content of the study programs, are included as occasional sub-topics. Practice is the mutual support in becoming a successful student at a distance (exchanging materials, reflecting on study strategies, jointly preparing for exams, etc.). The community element is strong as students deliberately join the network to reduce their isolation as distance learners. Relationships and collaboration, however, develop in very diverse forms (as strong and weak ties in the sense of Granovetter 1973), dependant of the individual student's choice, situation or needs. The community communication is complemented by a lot of personal communication, both computer-mediated and face-to-face.

The primary community space is a listserv. It has been supplemented by other tools (including a Yahoo Group, with a web-based discussion forum and data repository, individual web pages with community related data-repositories, etc.) in a completely decentralized manner. All resources and communication spaces are completely open.

The author's connection to this case is that of researcher: within her doctorate research project, Arnold was a participant observer in this community for one and a half years, conducted qualitative interviews with students and analyzed

community documents from data repositories as well as information material from the distance study program.

The students' initiative to organize the community can be seen as a response to the restricted educational design in place in their distance-learning program. This program is entirely individualized, based on print materials, with no group activities or cohorts being part of it. Students' influence on course content (and choice of fields of specialization) is very limited. The design of the program does not regard learners' products or students' peers as learning resources. In contrast, the situation within the students' community is the reverse: students' interim products in their studying activities, their reflections and professional experience are salient learning resources. Since there is no predefined community design in place, leadership roles are fully emergent. Students take up facilitating roles spontaneously. The same applies to context: there is no special "invitation" of context into the community, students enact their context in their actual practice of mutual support by giving advice, sharing background and expertise in a way they deem necessary to adequately answer a request. As the tools used in the community only support "thin" communication (e.g., plain text email) and all data is completely decentralized, successful practice relies on the right people spending the right amount of attention at the right time. This way the community context is open to frequent re-negotiation which also renders it somewhat fragile and dependent on a kind of systemic serendipity. Fragility is counteracted, however, by the comparatively long history that the majority of members share at a given time.

4 Learning opportunities – restricted and enhanced by community technologies

The three cases clearly illustrate the dilemmas of interest: ICT adds connectivity, offers new forms of negotiating identity and engaging in practice, thus supporting new forms of community and new learning experiences. But the visibility of context – individual and collective – is limited by ICT and therefore manifesting identity and engaging in practice gets impaired. Although self-description is important, the most effective means of inviting identity into a learning situation is not merely to provide for information *about* identity: being able to *manifest identity* and to engage in *practice* turns out to be far more important. In this sense *practice* is a test bed for a person's action in context. Our use of the term *identity* in this discussion goes considerably beyond the usage of the term as it's used, for example, in the context of member profiles in an online community (Kim 2000, 76). We see identity as being formed and transformed in communities of practice, a full reflection of a person's context in the social world.

In this section we explore how the mechanisms in the design and the improvisations of learners affect the learning in each situation, using identity and practice as central dimensions of our assessment.

We will first summarize the main contrasts in the cases in regard to the relationship under investigation and then present detailed results of the analysis:

Table 2: Contrasts in approach to context

Case	Contrasts discussed
Online Class: Context Invited-Aligning	• Less apparent need to bring in context, as students' individual context is **assumed** to be homogenous • Limited time restricts sharing of contexts and creation of group context • A single platform limits learner's choices, focuses on study materials
Online Workshop: Context Encouraged-Negotiating	• Comparatively higher need to expose context as participants are **assumed** to be heterogeneous • Different invitations at different points in time gather past, present and future context • Wide spectrum of communication modes gives many choices, some of which are confusing
Student Network: Context Enacted-Developing	• Self-organization and voluntary contributions make contributions reflect member's context, so it is **enacted** based on an assessment of personal value • Help given and received over long period accrues context • Providing resources such as summaries, websites, or archives takes initiative and demonstrates competence

Sharing and elaborating identity in online learning situations

Inviting identity in an online class

The design of the online class regards identity as being an important part of learning. The online space was carefully designed to enable students to describe their personal identity in the space at the start of the class. In the most recent offering, BSCW's facility for individual identity information (a personal card file with a picture, name, profession and contact information) was augmented by inviting students to pick a picture and then comment on their choice in their personal introductions. By choosing a picture and sharing it with the community for one's personal introduction, the text-only mode was augmented and invited richer and more emotive introductions.

Private journals that others could read were another mechanism to show the development of identity (and for this development to be a resource for the learning community). The journals were to be a means of experiencing a changing identity with growing expertise in scientific inquiries and procedures. This element did not find much acceptance, possibly because of the technology, the institutional context (i.e., the program included direct assessment of students' writing) or the fact that its social aspect was under-developed.

In a university class offered for credit toward a degree, the scope for negotiation around group context and identity is restricted, just as it is restricted around the scope and definition of the domain. As the community's context isn't negotiable as such, debate and reflection upon it is weakened.

The same applies for personal identity, even if not as strongly. Given clear instructional objectives – the acquisition of academic work procedures – participants' trajectories tend to evolve in "pre-designed" ways. In addition, BSCW's lack of support for spontaneous synchronous communication leaves comparatively little room for negotiation. The software platform's strength in supporting diverse and sophisticated asynchronous written communication, on the other hand, contributed substantially to the creation of entirely new forms of contributing to scientific debate: during the class the instructor, the guest experts and some of the students began to use a special style of "online keynote" to open up a thematic debate. Intended for an online space it was a "short and snappy" introduction, an unexpected innovation.

Encouraging identity in an online workshop

Because of the diversity of workshop participants, surfacing identity during the workshop's seven weeks is especially important. Both the workshop design and choice of technologies work towards this goal. Web Crossing's group awareness features include a clickable personal photo that heads written contributions; clicking on it retrieves an author's background and their five most recent postings. Functions that show "who's here" and make it easy to send "instant messages" help to connect people and build relationships through spontaneous encounters in the virtual space. By showing participant time zones as well as the time of their last visit to the online space the workshop's directory adds current contextual information (and gives clues about non-participation).

Several workshop design elements encourage the expression and discovery of identity. A "six degrees of separation" game, where each participant is challenged to identify connections and commonalities that link them in a chain to a given other participant, requires a lot of practice with the software, generates a great deal of information about the group and provokes a lot of good will. Small nominal groups (dubbed "households" with public "front porches" and private "kitchens") encourage postings that are directed to specific small groups, avoiding the impression of sending text into empty cyberspace. These groups create social context and take on significant community tasks. Small group discussions and self-selected project teams with different membership provide the opportunity for additional negotiation and learning in small groups.

The fact that there was neither certification at the end of the workshop nor a unifying organizational context with an aligning influence during the workshop shaped identity formation in its own way: the personal "standing" in the online community as well as individual satisfaction with what was achieved in the period of being together was the only reward for participation. This and the overall negotiability in place worked as an inherent incentive to learning as personal growth and an enriched identity.

However, identity formation and thus learning opportunities in this setting clearly favours people who are versatile in online communication (or become so very quickly). Non-native speakers of English found the pace and volume of interaction to be challenging. Surveys and interviews suggest that getting acquainted with the Web Crossing platform and contributing to the community

took up time and resources that theoretically might have been invested directly into engagement with the community or the subject matter. Again, opaque technology together with a tight time-schedule restricted learning opportunities or resulted in a bias of learning that discriminated unduly against some participants. On the other hand, those who are able to deal with technical, language, and scheduling obstacles are in many cases able to engage in significant collaboration that spills over the workshop's boundaries and into "the rest of the world."

Enacting identity in an open-ended network

At first glance in this situation there seems to be almost no surfacing of identity, either at the personal or community level. Because the student network community uses simple email and listserve technologies, the communication appears very "thin". Messages carry no contextual features other than a time stamp, date of posting and the name of the sender. Due to the decentralized nature of the community's development and the lack of any central facilitation or directory services, there is no centralized community space where the community's identity can be negotiated or be presented to itself or the world.

Further analysis suggests that, even with such simple technologies, small contextual cues such as message time stamps that convey important context saying, for example, "He is working the same odd hours as I am!" Just enough context seems to be provided – or enacted – explicitly through individual messages. Lots of context is re-constructed implicitly by the use of the common jargon and allusion to common study situations. The basic characteristics of member's context indeed seem to be very alike: rigid study regulations, limited choices and a constant struggle with one's personal time management. The struggle to keep motivated and to sacrifice much time over a long period creates a kind of shared context. This shared context then is invoked around personal requests or answers.

At the same time the community offers rich examples and opportunities to display personal identity – especially growing expertise in distance learning. Several people run personal homepages that act as data repositories for the community. They share personal experience in form of stories, reports and advice that show identity and demonstrate personal competence. Personal profiles, preferred links and other documents serve a similar function for the less technically adept.

Perhaps even more important for this community's sense of identity and learning is the community's ongoing life together. Regular meeting times for informal, face-to-face conversation, study groups to prepare for exams, and the occasional ad hoc meeting, all provide for the development of individual and group identity. Sub-communities form easily and like-minded people are easily found. In addition many kinds of "backchannel" communication connect people and provide opportunities to express and shape identity at a more personal level.

For the community as a whole, this results in a very diverse, multifaceted community identity. The basis for the community's vitality is a toleration or even celebration of diversity, based on the voluntary nature of participation. Each

member thus brings identity and context into the community, as appropriate. However, the basis for vitality constitutes the community's fragility as well.

Sharing and elaborating practice in online learning situations

Given that we regard peripheral participation in the practice as a condition for learning, separation between "the practice" and "the learning" becomes problematic. The extent to which the actual practice can be brought into the learning situation then depends on how context is handled. Whether learning situations are developed within the practice or the practice is somehow brought into a learning situation raises many questions about context and its meaning.

Aligning with academic practice in an online class

The online class was designed using a community of practice perspective. The domain for this community is the academic study of knowledge management and the practice entails reading, understanding and commenting on scientific publications, leading toward the development of new lines of argument and shared contributions. The practice of scientific inquiry as represented in the online class is similar to the practice in the larger scientific community: it happens asynchronously with an emphasis on the careful reading and production of texts. Having the opportunity for critical discussions with 4 or 5 guest experts and the instructor – all academic scholars or experienced practitioners located in several different countries – brings the essence of scientific practice into the classroom.

This part of the practice is supported well by BSCW. In fact the strength of BSCW is asynchronous written communication and working with texts: annotations, visual evaluation and version control. In contrast to a discussion in a face-to-face seminar, all contributions are permanent and can be easily retrieved and referred to later. Asynchronicity allows all participants to "let other people's points sink in" and is completely congruent with academic discourse as a debate made up of consecutive texts that reference each other.

The class design tries to bring scientific practice into the online classroom by inviting students to expose their personal practice in various ways: by keeping a personal learning journal (that is publicly visible) and by having several distinct collaboration spaces, practices of reflection, debate and learning are enacted online. Again, the permanent form of these reflections can serve as an important learning resource and a community practice can evolve and become visible.

Class evaluations, however, show that these design elements didn't live up to expectation for a number of possible reasons. Reflection on and discussion about one's own practice might require synchronous or less formal communication. The permanence of the written contribution might hinder tentative or preliminary thinking. BSCW doesn't support synchronous communication forms such as instant messages or chat and it does not show who is working online concurrently. The fact that a large part of the grade was based on the text produced by a student may additionally limit the kind of personal reflections students were willing to post. Similarly, the workspaces for the thematic focus groups who took up leadership roles for certain phases of the class weren't used much. Students preferred collaborating on their documents and

making arrangements via e-mail even though they had to make do without BSCW's special collaboration features. Again, institutional context came in strongly here and added to BSCW's collaboration features being far from transparent.

The short duration of the class was an additional obstacle to the evolution of collective practice. The class, again due to the institutional context, had to follow a strict time schedule. The time structure was not open for negotiation and might have restricted emergent learning opportunities as regards leadership roles and reflections on the individual and the community's practice. In the larger scientific community, the practice plays out over very long periods of time, limiting the extent to which participation during a semester-long class can include the full-fledged practice.

Negotiating the meaning of practice in an online workshop

In the case of the online workshop, contextualized practice receives strong emphasis. The cases that participants post in the Practice Lab – which range from informal stories to fully developed problems for group discussions – both focus attention on real practice and exemplify the kinds of discussions that go on in a community of practice. Participants take up leadership tasks to perform genuine community development work: their leadership shapes the workshop to a large extent. The under-design that was discussed earlier renders practice almost as open for negotiation as in any self-organizing community. In this way there are ample learning opportunities around leadership roles that actively shape and contribute to the community's practice. With feedback from other learners and workshop leaders, participants have a sense of moving to fuller participation.

In contrast to the online class, where the domain and practice seem quite suited to the online environment, the fact that most of the practice in the workshop happens via computer-mediated written communication may be a limitation. Although the communities that most participants are involved with have an online component, few are as international or as dependent on ICTs as the simulated community in the workshop. Even the use of telephone conferences, which were introduced to reduce the emphasis on text-based communication, has challenges associated with cost, time zone coordination, and the pace of spoken English for non-native speakers.

The institutional informality around the workshop allows innovation from one workshop to another, permitting it to grow from three weeks to seven weeks in length, for example. Improvisation during the "admissions process" so that email exchanges about communities of practice begin before the workshop formally begins is another outcome of this particular informal institutional context.

The ample scope for negotiation and for shaping the workshop community constitutes an important learning opportunity, encompassing behaviours ranging from active taking leadership to experiencing non-participation. The flexibility and degree of authority that participants have with Web Crossing permits participants to open discussions, set up conferences or change access controls. For

many people this results in some overload and a "lost in cyberspace" syndrome. Trying to find one's ways in other peoples' structures in an online space seems to be much more difficult than following a turbulent discussion in a face-to-face situation. And again technology is more opaque than it should be: to navigate through the hierarchical conference structure to find a certain element takes time. To learn how to find important statements and exchanges while coping with the volume of activity requires conscious attention to the technology and the evolving social practices.

Developing the practice in a student network

All that is needed to participate peripherally in the student network is to subscribe to the community's listserv. It enables passive participation without affecting active contributors. In fact, it is in line with an established culture of a high percentage of "lurkers" in mailing lists and newsgroups in general. Moving to fuller participation, i.e. asking questions, or sharing one's own strategies and experience as a distance learner is equally easy and can occur in different gradients of involvement and at a self-selected pace.

Technology used in this case comes close to being invisible. E-mails blend in effortlessly within daily working routines. Giving some advice or sharing resources with other students can happen in a few lines of text, using the established jargon of the distance education program. In this community, the sender of a message can assume a very similar situation at the receiving end of an email message, knowing that a familiar course curriculum and study regulations are being discussed. The practice of being a student is assumed, even though peripheral members may be piecing its elements together.

All communication serves the purpose of mutual support within the community. As messages are therefore assessed only on their helpfulness, there is no need to "polish" them. A quick and fragmentary style of communication that's precisely to the point has evolved, invoking a shared style. It seems to fully meet prevailing expectations and makes contributions efficient. It does not take much time and energy to make an active contribution and still the contribution is visible directly to an audience of several hundred fellow students (such economies of scale enable the existence of "gift cultures"; cf. Kollock 1999).

Moving to even fuller participation (actively enhancing the community's resources) is encouraged by the fact that students can contribute to the community and provide a test bed for their learning at the same time (at least in the case of the 50% or more who study business informatics). And the product (e.g., a website or repository) has a more permanent character and receives community wide attention.

In this way the community's practice evolves in a completely decentralized fashion, with lots of parallel developments and redundancies. The community's practice and its overall purpose are constantly negotiated anew. As a consequence, learning opportunities are widely available. At the same time, due to a lack of structuring or facilitation, explicit community memory and evolution of the practice also depends a great deal on good will and serendipity. Community development and learning thus is collective but remains fragile.

The limits of this community's practice become visible when students try to co-ordinate action (e.g., attempting to negotiate with the distance study provider as a student union). Co-ordination then seems too slow and inefficient to deal effectively with organizations outside of the community.

5 Conclusions

In this paper we began unpacking the complex relationships between technologies, learning and context. We were particularly interested in the way potential loss of context in learning situations that use ICT might affect the learning that takes place. Implicit was a concern to understand how learners, community leaders or designers cope with the loss of context. For this purpose we analysed three different learning situations. To be able to assess the effects on learning we used identity and practice as central dimensions.

Of course, these dimensions for our analysis don't reduce complexity as such. The relationships between context, the connectivity provided by ICT, and learning remain highly complex. By looking at these three situations, at the problems and the solutions that emerge in each case we can sharpen our perception regarding some of the inherent problems and trade-offs. By rendering each case more transparent through this analysis, the design and experience of each case can serve as a generative basis for other designs in different contexts.

We can summarize our results as follows:

1. "*Inviting context* into the online learning space" was a productive strategy in all three cases, although its meaning varied significantly. The various kinds of actions that are considered legitimate in each community are a reminder that it's not just a matter of bringing *representations of context* into cyberspace. Skilfully bringing context into an online situation is itself a context-dependent practice.
2. *No one technical solution* completely meets the needs found in a learning situation, so propagating technical solutions across multiple and diverse situations becomes even more problematic. Community technologies are not fully transparent, particularly when in every case they are enveloped in group practices, expectations, and interpretations.
3. *Narrative* appears everywhere as important, from the canonical stories of knowledge management to the stories of personal experience and advice as a distance learner. Design for learning in an online community therefore should always allocate space and attention to the generation of stories of various kinds.
4. *Negotiability* seems to act as a vehicle for surfacing identity and practice issues. If the design for learning entails no room for negotiation and participants don't feel they can meaningfully shape the learning situation, the presence of identity and practice are limited.
5. The role of *time* in the learning that occurs in a community is normally taken as a given and is non-negotiable in most learning situations. If regarded as an aspect of life in a community, learning naturally takes time and specific events – without which identity and practice do not emerge or evolve. It takes

time to negotiate roles and leadership, or for a community's practice to mature. ICTs themselves complicate the process and take time to become transparent – even saving time takes time and effort.

The communities of practice perspective for our analysis turned out to be a useful way to look at the learning situations under investigation. It helped to prevent us from unduly reducing complexity and falling back into the common trap of ignoring the lived-in world when looking at learning. At the same time it provides an analytical framework that allowed us to harness the effort that has been invested in each of the learning situations for further improvement and refinement.

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